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Abstract

This unit emphasizes concept-learning through the discovery approach and child-centered activities. "Discovering Matter" is treated in the kindergarten, "Matter Around Us" in grade 1, "Changes in Matter" in grade 4 and "Atoms and Molecules" in grade 6. The unit for each grade contains (1) understandings to be discovered, (2) activities and (3) activities to assign for homework or individual research. Each activity is introduced by a "leading question," followed by a list of materials and a description of the procedure to be followed. Children are taught to observe, infer, discuss problems and use reference and audio-visual aid materials. There is an index of science textbooks for reference for the teacher. The appendix contains listings of (1) common chemicals, (2) useful equipment, (3) laboratory procedures, (4) important chemical principles, and (5) chemical elements and their general characteristics. [Not available in hardcopy due to marginal legibility of original document.] (LC)

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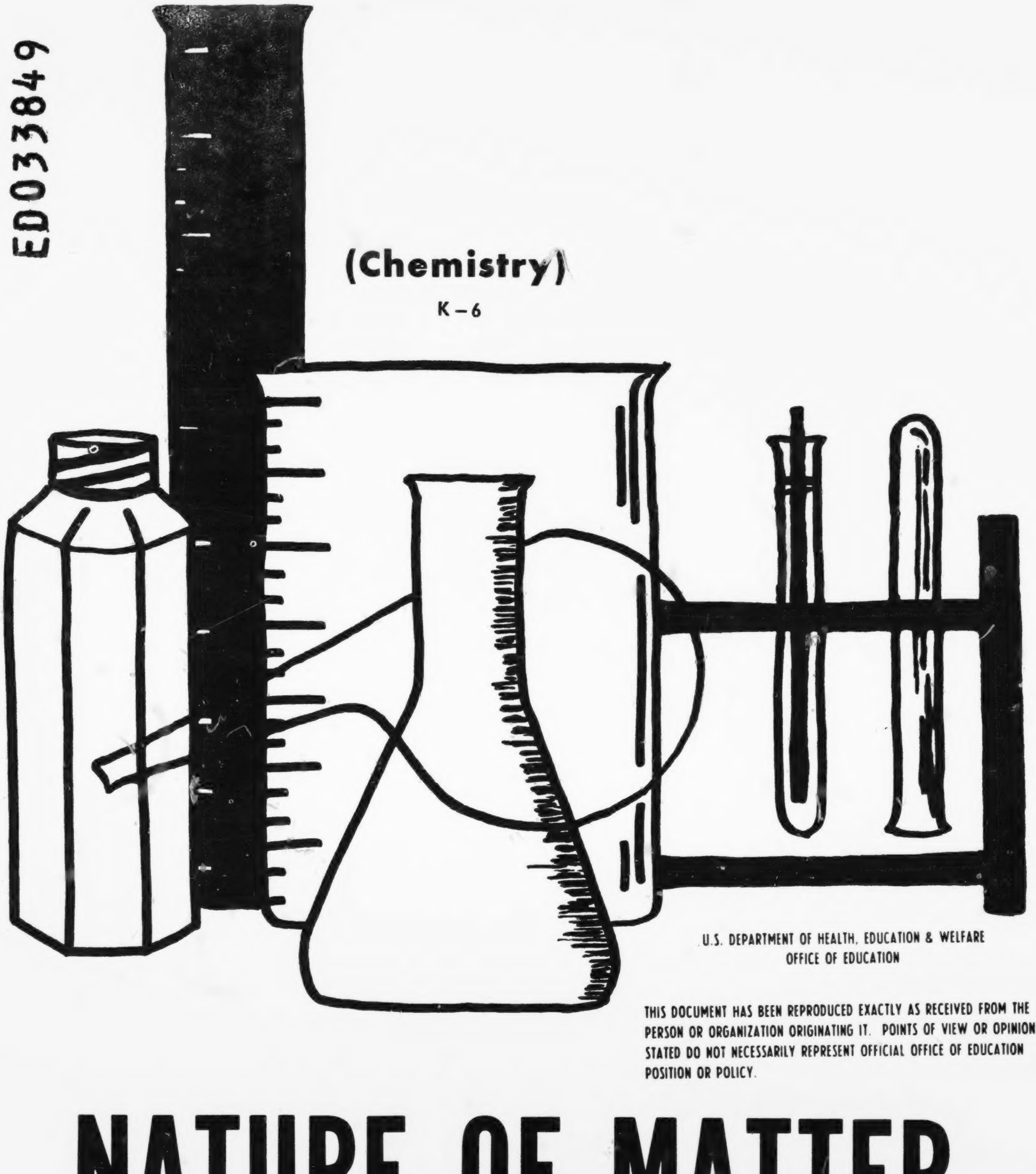
(Chemistry)

K – 6



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NATURE OF MATTER

SE007 472

Elementary Science Unit No. 4
1968

Bethlehem Area School District
Bethlehem, Pennsylvania

ED033849

NATURE OF MATTER

(Chemistry)

BETHLEHEM AREA ELEMENTARY SCHOOLS

Bethlehem Area School District
Bethlehem, Pennsylvania

1969

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Bethlehem, Pennsylvania

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FOREWORD

The NATURE OF MATTER is the fourth of a series of units to be written for the Bethlehem Area Elementary Schools. It is a major revision in both structure and content of the second edition of the Science Curriculum Guide.

In the first two editions of the Science Curriculum Guide all areas of science were part of the curriculum at succeeding grade levels with ever-increasing detail. This third edition will provide for differentiation of emphasis. Certain units will receive major emphasis at prescribed grade levels and minor emphasis at other grade levels. Designated grade-levels will not study particular units at all except as current events. The result will be that each grade level will study fewer areas but in greater depth.

The NATURE OF MATTER Unit should be studied in depth by the first, fourth, and sixth grades. Kindergarten will study the unit in less detail or with minor emphasis.

Second, third, and fifth grades will not have a Nature of Science Unit. The guide should be used as a resource and an aid in correlating the teaching of other science units.

The teacher should give thought to the best time of the school year to introduce and teach the unit - NATURE OF MATTER. Since the abilities of the children increase as the year progresses, the children can take a more active part in discovering and understanding the concepts put forward. This same consideration should be applied with all the developed science units in planning the years work.

Examination of the table of contents will disclose that there is very little repetition of areas studied in the various grades. However, understandings at one grade level build upon the understandings gained at the previous grade level and it may often be necessary to reteach understandings from a previous grade level. For instance, a child in third grade cannot understand seasons if he has not mastered the concepts concerned with the movements of the earth introduced in grade one.

The unit for each grade in this book will usually contain:

1. UNDERSTANDINGS TO BE DISCOVERED with a cross-reference

2. ACTIVITIES

3. ACTIVITIES TO ASSIGN FOR HOMEWORK OR INDIVIDUAL RESEARCH

The UNDERSTANDINGS TO BE DISCOVERED are listed for teacher reference and are to be developed through child-centered activities. A teacher should choose activities that best suit the need of the students. Obviously it would be impractical to use every activity listed.

Do not begin a lesson by stating a concept and proceeding to "prove" it with one or more experiments. Allow children to discover a concept in a learning situation. Children themselves should find solutions when confronted with a problem.

Teach children to observe, draw conclusions from observations, discuss problems with fellow students and other people, and to use a variety of references and audio-visual aid materials. Classroom textbooks should be used as reference materials in addition to the encyclopedia and books found in the library.

The science textbooks have been indexed for quick reference for the teacher in the NATURE OF MATTER UNIT. This index is not to be used by students. Children should practice basic reading skills by using the table of contents and index in their textbooks to discover pertinent references.

NATURE OF MATTER

Discovering Matter

Kindergarten

UNDERSTANDINGS TO BE DISCOVERED	RELATED ACTIVITIES
Everything around us is matter.	1, 7, 8
Matter is discovered through our senses.	2, 3, 5, 8
Matter exists as solids, liquids, and gases.	4, 5, 6, 9
Matter changes constantly.	10, 15
Matter can be mixed.	11, 12
Matter can change shape.	13, 14
Matter is affected by temperature.	15
Some matter can be dissolved.	11
Some matter cannot be seen.	14, 15, 16, 17, 18

NATURE OF MATTER

Discovering Matter — Kindergarten

ACTIVITIES

1. Leading Question: Can you find and tell?

Materials: Ball, scissor, string, chalk crayon, etc.

Procedure: Orientate the children by having explorations about the room in search of different objects. Show and tell about the object. (Is it hard? Is it soft? Does it pour? Is it heavy? Does it take up space?)

Perform activities related to object:

bounce ball
cut with scissor
write with crayon

Informally group objects found. Observe, discuss and compare.

Take an excursion around the playground and the block to notice objects in environment. Notice shape, size, weight, texture, color, stillness, moving objects, walking on ground, stubbing toe on rock, wood in forest,etc.

Encourage children to notice objects within the home to discover.

Collect and arrange pictures illustrating matter and display these on a chart.

2. Leading Questions: How do you discover?

Materials: Objects in the room - clips, paper, water, etc.

Procedure: Ask the children: How do you know this is a _____? Can you see it? Can you tell the shape and color? Can you tell how it feels? Does it make a noise? Does it have an odor? What else can you tell about this object?

Examine it closely; arrange in groups on chosen space.

3. Leading Question: Surprise?

A. Materials: Packages brought from home

Procedure: Children sit in a ring on the floor to pass and examine objects concealed in paper bags.

Ask the children: What can you tell when you listen, smell, look, and shake? Can you guess the hidden object?

B. Materials: Perfume, vinegar, powder, oil, onion, etc.

Procedure: Blindfold child and encourage him to tell about objects with the nose sniffing. It is fun to discover as well as to see who can guess the most objects.

4. **Leading Question:** Oh dear! What can the matter be?

Materials: Rock, water, pan, glass, marble, food coloring, straw, balloon, soap bubbles

Procedure: Experiment with an empty tray or pan. Drop water on the pan. What did the water do? (Splashed or puddled)

Drop a rock or marble. What happened? (Did not break but rolled)

Drop colored water over rock. Observe. What occurred? (Water went around and over rock)

Place an empty glass upside down and encourage a response about what is inside the glass.

Blow water with a straw to produce air. Does the water move? What could move it?

How are you able to blow up a balloon?

Submerge an air filled balloon in an aquarium and notice the results.

Why can you blow into a bubble mixture and make a bubble? Demonstrate.

Note to teacher: You should now have gathered and sorted much material for identification of objects and their likenesses and differences. Encourage children to group the various materials according to their physical properties.

5. **Leading Question:** Can we see air?

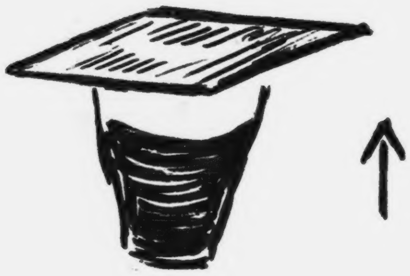
Materials: Cloth, glass, paper, straw

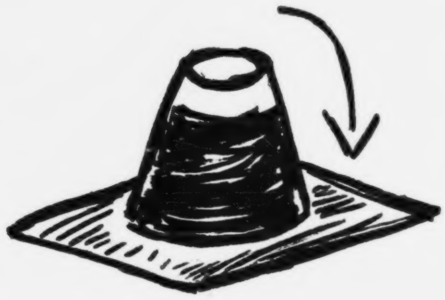
Procedure: Put a small cloth in the bottom of a large glass and turn the glass upside down. What will happen? Will water enter the glass? Push glass straight down into water. What will happen? Pull the glass out of the water and remove the cloth. What do you see? Why is the cloth dry? Help the children to conclude that air keeps out water and takes up space.

6. Leading Question: Where is air?

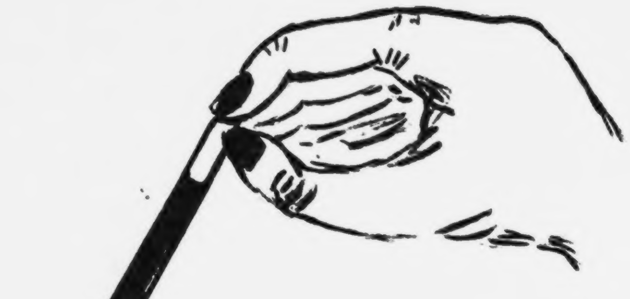
Materials: Paper, glass, water, straw

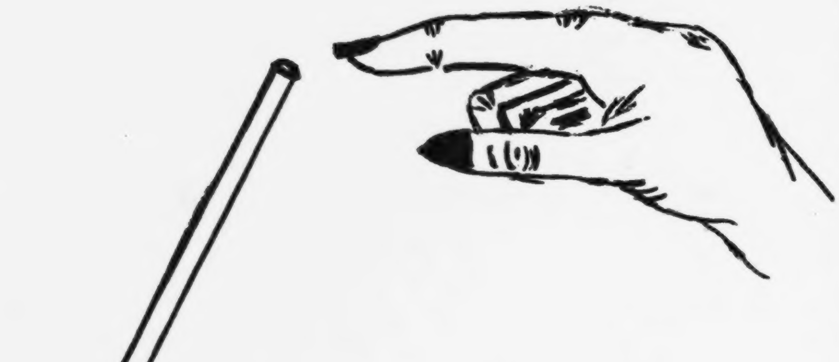
Procedure: Press a peice of paper tightly to the top of a glass filled with water. What cannot come into the glass? Find out what happens when you turn the glass over. Help the children to discover why the water does not run out and what could be pushing on the paper.





Carry some water in a straw by holding your finger at the top. Discover what happens when you remove your finger and lead into the discovery of what pushes into the straw. Instigate the child to conclude that air is everywhere.





7. Leading Question: What matter do you use?

Materials: Chart

Procedure: Emphasize recognition and identification of objects the children use. Discover and discuss likenesses and differences. Display in chart form, perhaps by using actual objects.

8. Leading Question: Can you help objects to be friends?

Materials: Overhead projector, small objects like pins, buttons, colored paper shapes, etc.

Procedure: Place objects in disarranged fashion on an overhead projector. Identify the objects, describe them, and arrange them in matching groups.

Divide the class into two or three groups. Distribute two or three boxes with even amounts of different objects. Devise a game whereby children compete to arrange like objects as quickly as possible.

9. Leading Question: Can you tell about solids, liquids, and gases?

Materials: Plastic bags, plastic dishes, rocks

Procedure: Show a bag containing a rock and ask for a response. What is in the bag? Show a bag of water and ask for a description. Show an empty bag and encourage children to reveal that nothing can be seen. Allow children to experiment by using their senses to find out more about each of the three bags. Encourage children to investigate the empty bag and experiment to see if they can fill the empty bag with air.

10. Leading Question: Why does matter change?

Materials: Hammer, rock, dried leaves, plant

Procedure: Encourage children to observe that many things change around them continuously and can be seen changing. Question them on changes they can recognize.

Ask the children: Do rocks change? (hammer soft rock to pebble then to dirt) (shake soil in jar of water) Do plants change?

(Watch growth process) Does your pet change? How? Does mother change things when she cooks? What and how? How do you change?

11. **Leading Question:** Can you make magic with water?

Materials: Jars, spoons, coffee, detergent, oil, soil, wheat flour, jello, prunes, paper, sand, salt, paint, sugar, wood, etc.

Procedure: Provide sufficient amounts of jars and spoons for mixing various materials. Perhaps group division at different tables would provide stronger interest as grouped children mix materials. Remember to compare results, observe reactions, and display and discuss mixed samples. Discover what has mixed with water and what has not. Encourage experiments at home to be brought to class. Investigate and group all materials on display table.

Note to teacher: Since the words solid, liquid, and gas might present problems, no special attempt is being made to define them. The activities will lend themselves to understanding.

12. **Leading Question:** Is magic in change?

Materials: Food coloring, soap, rocks, sand, strainer, plaster of paris, lemonade, cocoa, butter, ink, water color, etc.

Procedure: Allow the children to discover when we:

add food coloring to water
make soap bubbles
separate rocks from sand with strainer
construct plaster of paris molds
concoct lemonade or cocoa to drink
let ink drop on paper; then press for design
mix paint and water; then demonstrate
shake cream into butter

13. **Leading Question:** How can you change shapes?

Materials: Scissors, balloon, paper, foil, foods, etc.

Procedure: Ask the children to assist you in changing the shape of materials after provoking a discussion on how the physical aspects of an object can change. Proceed to demonstrate and urge the children to experiment:

Peel a banana (cut, mash, slice)
crush a cracker
chop celery
slice pickles
break candy
crush tin foil
stretch a rubber band or elastic
cut paper
burst a balloon

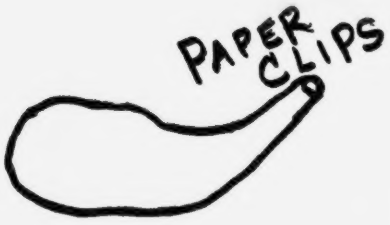
Instigate responses on how these and other materials change and how the change occurs.

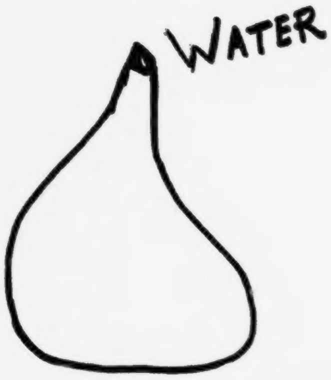
14. Leading Question: How does matter behave?

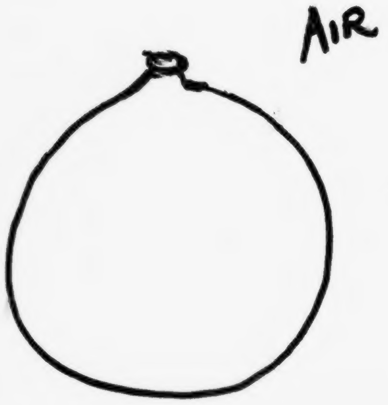
Materials: Three balloons, paper clips, water

Procedure: Have three balloons displayed and direct a child to fill one with paper clips, another child to fill one with enough water to give the balloon shape, and the third child to fill the last with enough air to give the balloon shape. Tighten tops of balloons securely.

Allow children to recognize that by feeling the balloons, they will notice paper clips do not flow or change shape, but that the water and air flow and take the shape of the balloon.







15. **Leading Question:** How can hot and cold change matter?

Materials: Hot plate, water, one cube tray, jello, chocolate, glass, tar, ice cream, napkin, etc.

Procedure: Allow children to observe you filling an ice cube tray to the brim. Freeze. Ask them to predict the results of freezing. Notice how water "grows" when frozen by producing larger cubes than amount of water placed in the tray. Melt cube in desired fashion and then boil the water. Allow the children to feel the force of vapor and demonstrate by floating light paper or napkin atop boiling water. Notice rise and fall of mercury (alcohol) in thermometer.

Prepare jello.

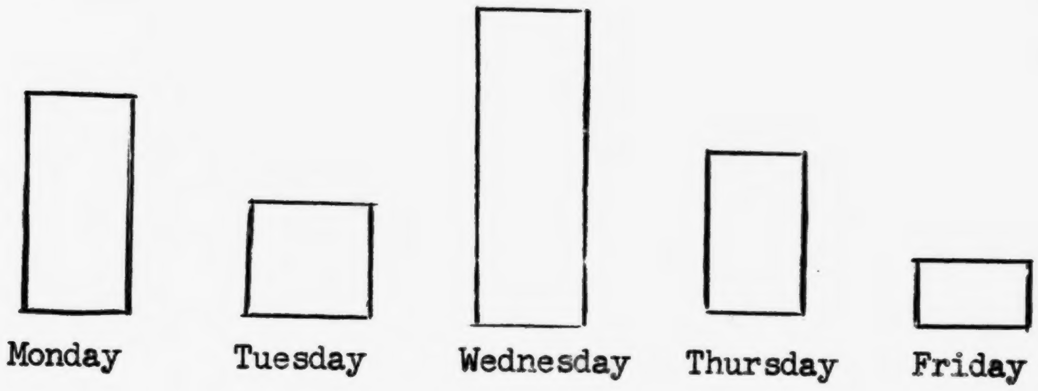
Notice melting tar on the playground.

Melt chocolate.

Run a tightly capped jar under hot water and pose the question of whether or not heat makes matter grow also. (Heat expands cap)

Pour boiling water in a cold glass. (Glass will crack - CAUTION)

Relate and discuss concrete experiences with children concerning hot and cold and changes occurring, such as ice cream melting on warm days, snow freezing, etc.



Use paper to illustrate degree of temperature each day, then cut to size. Children could also color rise and fall in temperature on evenly cut strips.

16. **Leading Question:** What keeps a balloon up?

Materials: Baking soda, citric acid crystals, salt, water, test tube, magnifying glass or giant tripod magnifier

A. Procedure: Develop the idea of the difference between gas and gasoline by expounding upon an experience of the children at the circus or fair. Describe and develop.

Ask the children how the man at the fair fills his balloons. Ask how you can inflate a balloon without blowing into it. Lead the children to understand that the liquid gasoline that Daddy uses does not compare to air as a gas.

Prepare about four tables with four containers filled with even parts of materials listed above and ask children to help you make gas to inflate balloons.

Identify four ingredients and first allow children to experiment by mixing any or all of the products.

Encourage observation through the use of the senses and help them control the experimentation of mixing.

Direct children to examine and describe the bubbling mixture through magnifying glasses. (Giant tripod magnifier works very well!)

B. Procedure: Two methods to inflate the balloon:

Mix dry ingredients in test tube and place water in balloon. Attach the balloon opening to the top of tube and quickly combine by dropping water into tube.

Place dry mixture in tube and add water with medicine dropper.

17. **Leading Question:** What about air?

Materials: Kites, pinwheels, tire, clothes, paper bag, and balloon

Procedure: Ask the children if they can see the air they breathe, the air from an inflated balloon, the air in a glass or jar, etc. Conclude that air is colorless and lead into the possibility of moving air.

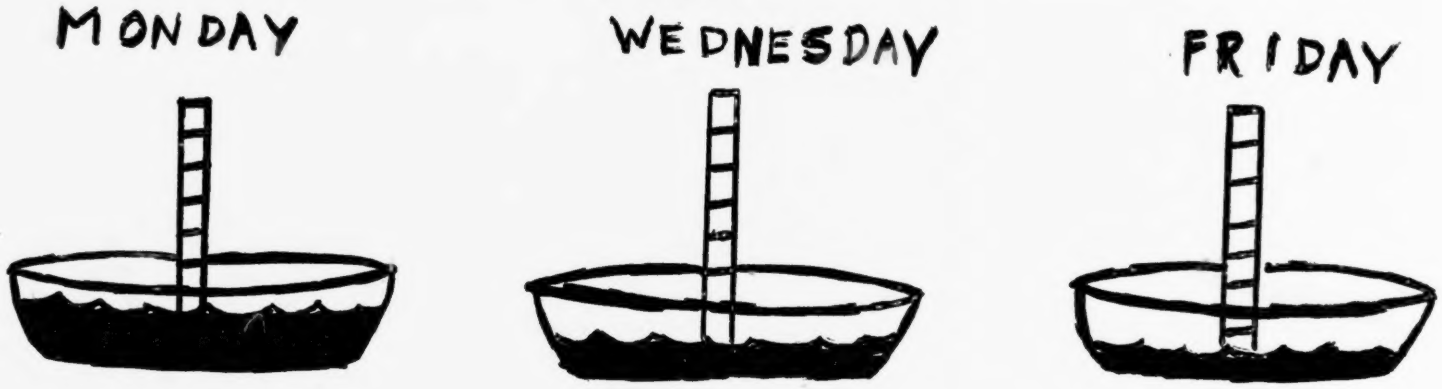
Ask the children if they can feel air by making it move. (Wave arms, swing around, etc.) Discuss what air does when it moves in many places. Observe:

tire being filled
clothes drying
popping a paper bag
blowing up balloon
affect on classroom made pinwheels and kites
pictures of wind (songs and stories)

18. Leading Question: Do wind and water work together?

Materials: Blackboard, cloth, pan

A. Procedure: Place a pan of water near an open window and allow the children to measure lessening amounts of water.



Observe and measure each pan with ruler or other measuring device to record evaporation.

Mark off two places the same size using different shapes on a blackboard. Rub both with a wet cloth and fan one to see which dries first.

B. Procedure: Blow on a pan of water to see the waves.

C. Procedure: Wash three like articles of clothing and hang two the same way while folding the other to discover which dries faster. Then hang one in sunshine and one in the shade to again discover which dries faster.

NATURE OF MATTER

Matter Around Us

Grade 1

States of Matter

UNDERSTANDINGS TO BE DISCOVERED	RELATED ACTIVITIES
All things on the earth are matter.	1, 2
Classifying the many materials help us to learn more about them.	1, 2, 3, 5, 6
Some matter is living and some is non-living.	6, 7
Matter exists in three states: gas (vapor,) liquid, and solid.	4, 5, 6, 8, 9
Matter can be measured.	10, 13
Matter has weight.	10, 13, 14
Matter takes up space.	7, 9, 10, 14, 16
Matter can be identified because of specific properties.	15
Air is matter.	8, 16, 17, 20
Air is called a gas.	13, 18
Air takes up space.	9, 11, 12, 16, 17, 20, 25
Air has weight.	11, 12
Air is everywhere.	19
Air moves some matter.	20
Air exerts pressure.	17, 21, 22, 23, 24, 25, 27
Air contains many different materials.	26
Air does work for us.	28

NATURE OF MATTER

Matter Around Us

Grade 1

Changes of Matter

UNDERSTANDINGS TO BE DISCOVERED	RELATED ACTIVITIES
Matter can not be created.	29, 30
Matter can be changed from one state to another by adding or taking away heat.	43
Matter is made up of small particles called molecules.	31, 32
Molecules are always moving.	
Matter combines with other matter in a variety of ways.	33, 34
Heat speeds up the combination of matter.	35, 38
Water changes through evaporation.	36, 37, 38
Heat causes many materials to expand.	39, 40
Lack of heat causes many materials to contract.	41
Matter can be cooled or heated by air.	42

NATURE OF MATTER

Matter Around Us Grade 1

ACTIVITIES

1. Leading Question: Can you find 10 different types of matter in the room?

   Materials: None

   Procedure: Divide the class into groups. Assign each group to a different area of the room. Have the group name ten different things that they think are matter.

   Ask the students how these materials are alike and how they are different.

   The children should realize that all materials are matter.

   Note to teacher: Matter is defined as anything that takes up space and has weight. Use the word matter frequently to develop this idea.

2. Leading Question: What is matter?

   Materials: Various materials brought in by students

   A. Procedure: Have children bring in objects which they think are matter. Objects in the classroom may be gathered and collected in one area.

   Ask the following questions about each object:

   Can we measure it? (Bigger or smaller)
   Does it have weight?
   Does it take up space?
   Does it have color?
   What shape is it?
   Can you hold it?
   Can it be stretched?
   How does it feel? (smooth-rough)

   Note to teacher: The children should realize that all materials are matter.

   B. Procedure: Refer to Holt, Rinehart and Winston materials box and charts. (Kindergarten classroom) Have children identify objects according to size, shape, color and texture.

3. Leading Question: Can you solve a mystery?

Materials: Suggested: shampoo, water, cinnamon, pepper, perfume, other, beakers

Procedure: Fill four beakers with mystery materials. Label them A, B, C, D. Using the chart illustrated, select members of class to identify the substances in the beakers.

	Mystery Materials			
Beaker	Gas, Liquid, Solid	Color	Odor	Prediction
A				
B				
C				
D				

Note to teacher: Prepare a group of boxes with unknowns and play the same game as an extra, perhaps free time activity.

4. Leading Question: Let's play: Gas, Liquid, Solid.

Materials: Large signs in the corners of the room labeled: Solid, Gas, Liquid, pictures of states of matter

Procedure: Give each child a picture with an example of matter. Let the children walk to the corner of the room to the picture which corresponds to their picture.

Note to teacher: This should be an oft repeated activity.

5. Leading Question: Would you like to play a guessing game?

Materials: Large table labeled with signs: Solid, Liquid, Gas

Procedure: Each child is to bring in three samples of matter or pictures of matter. As the child shows his sample, the class guesses to which group (gas, liquid, solid) it belongs. After the matter has been classified, it may be placed at the proper place.

Note to teacher: Later select several different samples and mix them up. Let the children rearrange the items in a play situation.

6. Leading Question: What things are alive?

Materials: None

Procedure: Discuss things that are alive (living) and things that are dead (non-living). Take a walk and ask them to look for things living and non-living.

Upon returning to the classroom lead a discussion that results in a classification of living and non-living things.

Note to teacher: Emphasize that all things in the world take up space.

7. Leading Question: Is all matter living?

Materials: Pictures brought from home, bulletin board or chalkboard divided into two sections: living/non-living

Procedure: Children are to bring in pictures of living and non-living matter. Each child classifies his own picture.

After classifying matter as living and non-living, reclassify the pictures as to gas, liquid, and solid.

Note to teacher: A supply of pictures depicting gases might be collected in advance.

8. Leading Question: What shape is air?

Materials: 3 plastic bags, few small rocks, food coloring, aquarium or large jar filled with water, water

Procedure: Fill one bag with colored water, the second with rocks, and the third with air, (fill the bag by a sweeping motion.)

Empty the bag of rocks into the aquarium. Ask: Do they keep their shape? Then empty the bag of colored water into the aquarium. Ask: What happened to the water? (note the diffusion of the color). Empty the bag of air into the aquarium by putting the mouth of the bag in the water. The children discover that if nothing holds a gas it spreads out and has no shape.

Note to teacher: Additional material including containers and plastic bags may be used following this demonstration to emphasize the principle that air takes the shape of the container that holds it. Divide the class into groups and allow each child to fill his bag with air (using a sweeping motion) and empty it into the containers.

9. Leading Question: How are things different?

Materials: Plastic bags (one per child), small rocks, wire fasteners for the bags, water, paper cups, large pan

Procedure: Divide the class into groups of three. Supply each group with a paper cup of water, and a few small stones. In each group one child fills his bag with stones, one with water, and one with air (use a sweeping motion.) Tie each bag with a wire fastener.

Have all the children feel and describe the contents of each bag. Through discussion these observations should be made:

1. Rocks are round, hard, and have sharp edges, etc.
2. Water takes the shape of the bag.
3. Air fill the bag completely.

As the child empties each bag into a pan help the class observe that rocks keep their shapes, the liquid takes the shape of the container, and air, while it can be felt in the bag, cannot be seen.

10. Leading Question: Which takes up the most space?

Materials: Classroom objects

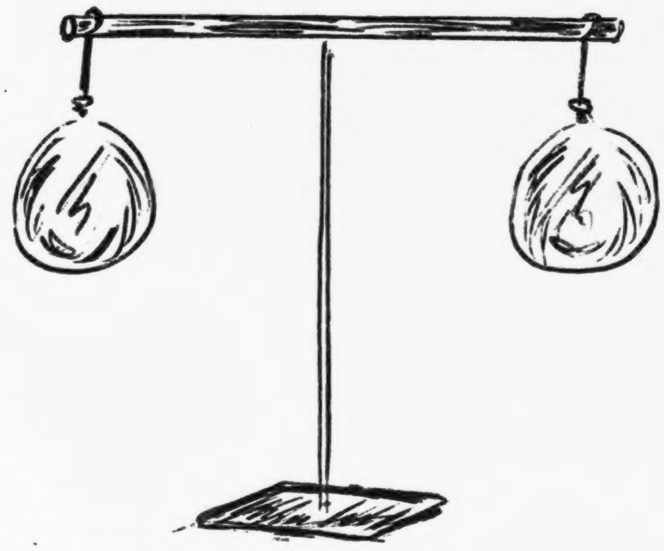
Procedure: The class should discuss objects in the room as matter. Discuss which objects are larger or smaller in relationship to each other. Then go outside and discuss largeness and smallness of trees, buildings, etc.

Note to teacher: Try to have the children use the term "matter" in their questions and written work.

11. Leading Question: Does air have weight?

Materials: Stand from Welch Machine Kit, string, balloons, ruler

Procedure: Using the Welch Machine Kit stand, suspend two inflated balloons so that they balance the ruler that pivots on the vertical rod. Break one balloon and observe the position of the ruler.



12. Leading Question: Does air have weight?

Materials: 2 volleyballs, air pump, balance scale

Procedure: Deflate one volleyball or basketball and inflate the other volleyball. Use a balance scale to show that the one with air is heavier. Then pump up the deflated ball and show the children that they now both weigh the same.

Note to teacher: Same experience with the trip balance scale may be beneficial to prepare the children for this experiment.

13. Leading Question: Which is heaviest?

Materials: Balance scale, beaker of water, soda, pencils, etc.

Procedure: Lead a class discussion about the weight of different objects. Have the children predict which is heavier. After predicition and estimation, weigh the objects.

Note to teacher: Use a balance scale.

14. Leading Question: How many things will fit in this box?

Materials: Cardboard carton, many different objects such as books, pencils, crayons, jars, erasers, etc.

Procedure: Have the children see how many things they can put in the carton. Help the children see that if the things are arranged neatly, more things can be placed in the box.

Lead the children to the conclusion that matter takes up space.

Note to teacher: Having the class divide into several groups for this activity will allow for the greatest participation.

15. Leading Question: Let's have a treasure hunt!

Materials: Matter brought from home

Procedure: Have each child bring in 5 things of different materials. Test the materials and make a chart to classify:

Does Not Bend	Stays Bent	Bends Back	Breaks	Odor	Others

TEST THE MATERIALS IN WATER

Floats	Sinks	Dissolves	Swells Up	Nothing	Bubbles

16. Leading Question: Can you carry water in a straw?

Materials: Straw or glass tube

Procedure: Transfer water from one container to another by holding the finger over the end of a glass tube. Allow each child to try this experiment.

Note to teacher: This method is useful in removing foreign materials from aquaria.

17. Leading Question: What makes milk come up the straw?

Materials: Straw or glass tube, 2 containers of milk, candle, matches

Procedure: Place a straw into a container of milk. Have several students, using different straws, drink from the milk.

In one container seal the hole in the straw with wax. Allow a child to drink through the straw. Have him tell the class the difficulty he has getting the milk.

Help the children explain that the wax has cut off the air supply and that the air no longer is pressing on the surface of the milk thus forcing it through the straw.

18. Leading Question: What is a gas?

Materials: Straw, glass beaker, bottle of soda

Procedure: Blow bubbles in a glass beaker.

Shake a bottle of soda.

Help the children discover that air is a gas but it is also matter. Help the children realize that there are many types of gases and that it is not air but a different gas which causes the bubbles in soda.

19. Leading Question: Is there air in a brick?

Materials: Soil, brick, stones, bread, erasers, sponge, etc., large glass jar

Procedure: To water partially filling a glass jar, add a brick and observe the bubbles. Use other materials to show that there is air in many things.

20. Leading Question: How can we "see" air?

Materials: Paper, bottles, glass tubing, oaktag, cardboard Erlenmeyer flask, one-hole stopper, two-hole stopper

(1) Procedure: Swing around arm with palm flattened.

(2) Procedure: Blow up balloons.

(3) Procedure: Blow on scraps of paper.

(4) Procedure: Watch a candle flicker.

(5) Procedure: Try to close door suddenly against a closed room or closet.

(6) Procedure: Observe curtain move.

(7) Procedure: Drop a sheet of thin paper and note that it seems to be supported.

(8) Procedure: Hold an "empty" bottle mouth downward in water. Gradually tilt bottle. Note bubbles of air as they rush out.

(9) Procedure: Hold finger tightly over piece of glass tubing. Insert lower end in water. Remove finger gradually and note water.

(10) Procedure: Swing a piece of cardboard through air edgewise. Then swing it upright.

(11) Procedure: Repeat #7 using cardboards of different sizes.

(12) Procedure: Hold sheet of paper on flat of hand. Run and turn hand over gradually until paper is held against it by air pressing on it.

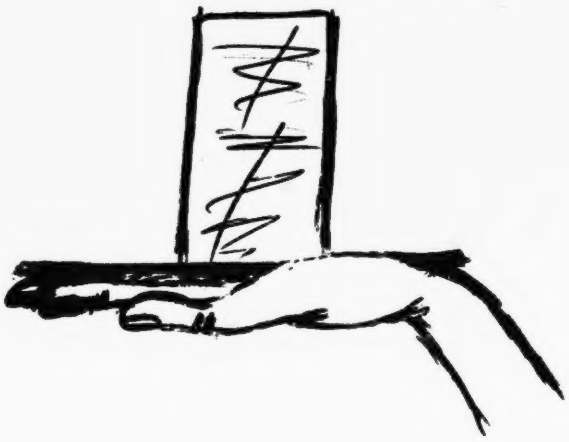
(13) Procedure: Invert "empty" glass into a basin of water. No water rises in glass. Tip glass and allow air to escape in bubbles. Water will fill the glass as the air escapes.

(14) Procedure: Take a bottle with a one-hole stopper to fit. Insert a glass funnel in the hole or make a paper funnel to fit. Try to pour water down the funnel to fill the jar. Water does not enter. Replace one-hole stopper with two-hole stopper. Water enters readily as air leaves via the second hole.

21. Leading Question: Can air hold up water?

Materials: Glass tumbler, oaktag or cardboard, water

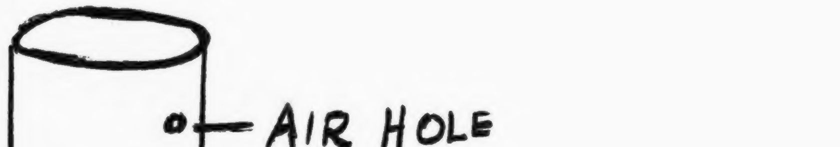
Procedure: Fill a glass tumbler with water. Place a piece of paper over the glass with palm of hand. Invert and carefully remove hand. Water remains in the glass due to air pressure. (With practice a larger container may be used to make it more vivid.)



22. Leading Question: How can air press on things?

Materials: Coffee can with plastic lid, water, large pan

Procedure: Use a coffee can with tight fitting plastic lid and punch two holes in the can as shown in diagram. Fill the can half full of water while holding finger over holes. Fasten air-tight lid. Cover side hole and remove finger from the bottom of the can. Note the water does not run out. Remove finger from side hole and observe that water runs out.



23. Leading Question: What can a potato lift?

Materials: A potato, plate, or piece of glass

Procedure: Cut a potato into slices and press them against a dinner plate. Have a child raise the plate with a potato.

Help the children understand that the lack of air in one place (under the potato) causes other air to press on the area causing suction.

24. Leading Question: Can air press on things?

Materials: Rubber suction items

Procedure: Have the children experiment with rubber suction types of everyday houshold articles such as towel racks and sink plungers. Have children bring in things from home that work on the suction principle.

25. Leading Question: Is there air in the bottom of a hole?

Materials: Ballons, net or rack of some kind

Procedure: Help the children see that air moves because the molecules press each other down. There is some air at the bottom of the deepest hole. Molecules are farther apart high in the atmosphere.

There is almost no air between the earth and the moon.

Stack balloons in a large net or some other contrivance to show this principle.

26. **Leading Question:** What's in air?

Materials: Beam of light (flashlight, projector)

Procedure: Shine the beam of light in a darkened room. Sometimes sunlight through a window make a good beam. Shake an article of clothing or clap erasers together to show how dust is in the air.

Discuss other ways and other materials that get into the air. Make a chart and let members of the class draw pictures. The pictures may be labeled factories, fires, soil, cars, plants, clothing.

27. **Leading Question:** Does air press in all directions?

Materials: Balloon for each child

Procedure: Ask each child to blow up a balloon. Lead the children to discover that the balloon is evenly hard on all sides.

28. **Leading Question:** How can air work?

Materials: Air pump, ball, tire, spray gun, aerosol cans, kites, sailboat

Procedure: To show that air is useful and does work for us do the following:

(1) **Procedure:** Pump air into a ball or tire (air acts as a cushion).

(2) **Procedure:** Collect pictures showing how air acts as a cushion.

(3) **Procedure:** Fill a spray gun with water and show how air under pressure works for people.

(4) **Procedure:** Collect empty aerosol cans to show how air under pressure is used in many ways. Discuss safety in disposing empty aerosol cans.

(5) **Procedure:** Discuss ways air help us:
(a) Kites
(b) Sailboats

29. Leading Question: Can we change materials?

Materials: Tempra (dry), glue, construction paper, clay or play dough

Procedure: On a piece of construction paper, paint on tempra and glue. When both have dried, have the class describe the tempra and glue.

Experiment with clay or play dough. Let the child describe the "changed matter" after the clay has dried.

30. Leading Question: Can you make rust?

Materials: Steel wool pads (not soap

Procedure: Cut a mass of steel wool (not soap pads) in half. Wet one of the masses and place each on a table.

Lead the children to understand that rust was made by the particles of steel combining with the air.

Observe with the children that matter (rust) was not created but a result of a change.

31. Leading Question: How can perfume float on air?

Materials: Strong perfume or aerosol can of room deodorizer

Procedure: Have all the children face the front of the room. Open a bottle of perfume and have the children raise their hands when they smell the perfume.

32. Leading Question: Why does air go through things?

Materials: Screening, tissue, stockings, etc.

Procedure: Blow through a piece of screen.

Blow through a paper tissue.

Have children feel air passing through their clothes.

Tell the children that air is made up of little parts so small you cannot see them. They are called molecules.

Help them understand that air moves through little holes and little spaces.

33. Leading Question: Do all materials mix?

Materials: Vegetable oil, water, beaker

Procedure: Into a large beaker pour oil and water. Allow the mixture to settle. Help the children see that oil and water do not remain together and will separate. Discuss other mixtures at home that separate. An example would be oil base paint and water. Discuss what solvents are used for paint, shellac and varnish.

34. Leading Question: How can we combine materials?

Materials: Food color, salt, sugar, soda, water, milk

Procedure: Demonstrate one mixture and let the class, working in groups, experiment by combining materials to investigate results.

The results could be described and charted.

35. Leading Question: What happens when we heat air?

Materials: Two glass measuring cups, hot plate, ice cubes

Procedure: Pour soda into one measuring cup. Heat and observe the rapid action of the gas bubbles.

Pour soda into the other measuring cup and add ice cubes.

Help the children discover that heat makes gas molecules move faster when heated.

36. Leading Question: What happens to a puddle?

Materials: Sponge, water, glass

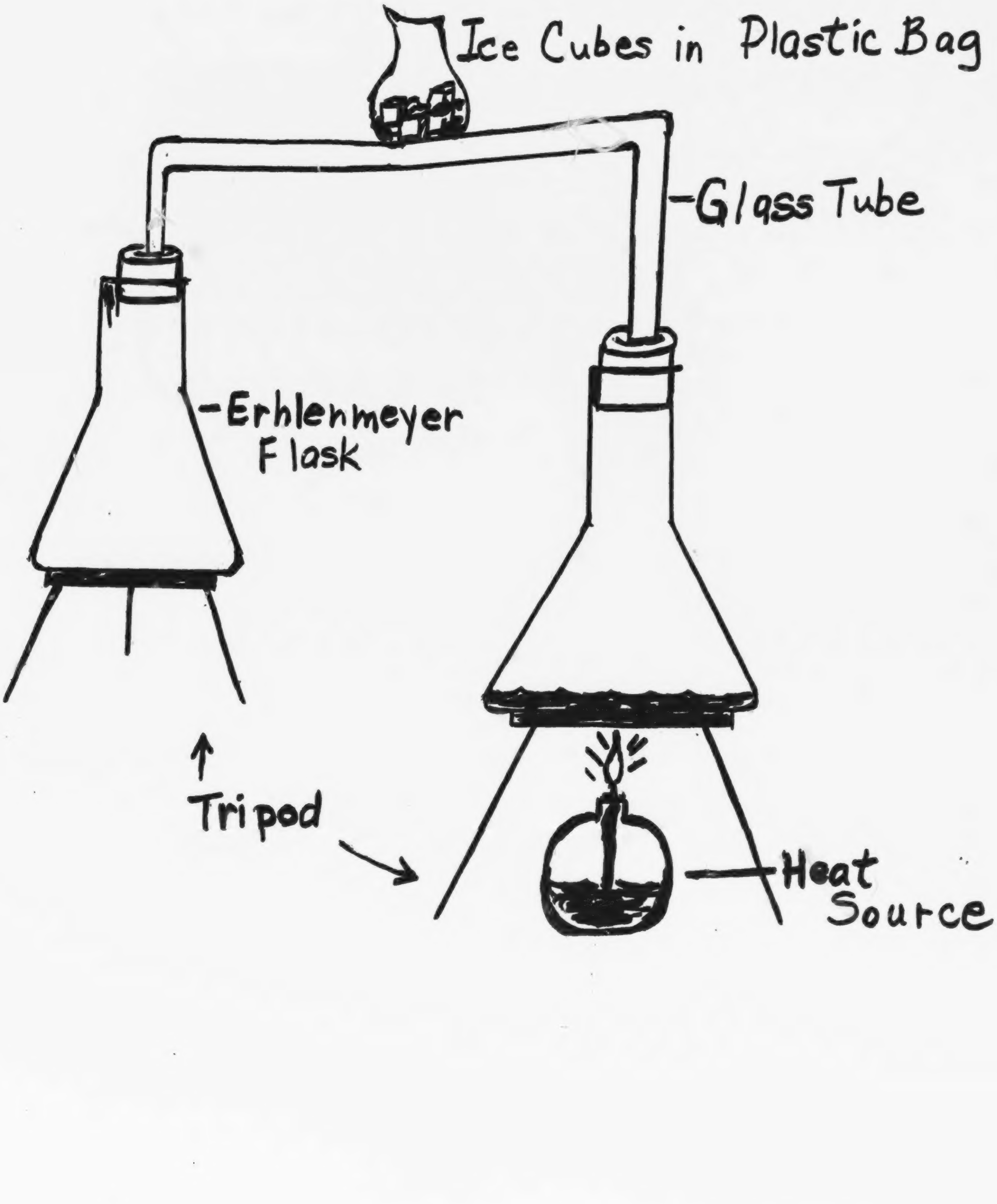
Procedure: From the wet sponge drop 10 drops of water into the glass. The next day let a child count the drops. Introduce the word evaporate. Explain that the water changed to a gas called water vapor. When water changes to water vapor it goes into the air.

37. Leading Question: Can we make water reappear?

Materials: Two Erlenmeyer flasks, stoppers, glass tube, ice cubes

Procedure: Set up the demonstration as illustrated. Boil a small amount of water until it evaporates passing through the glass tube. By holding ice on the tube, rapid condensation will take place and the water will collect in the other flask.

Note to teacher: Try this with muddy water.


Ice Cubes in Plastic Bag
Glass Tube
Erhlenmeyer Flask
Tripod
Heat Source

38. Leading Question: How can you put water in the air?

Materials: Two glasses, scotch tape, medicine dropper, ice water

Procedure: Put two drops of water in the bottom of a glass. Invert the other glass and tape the two glasses together. Let the chamber stand in a warm place. Examine the chamber after a few hours. The drops of water have now disappeared, yet the water must still be inside.

Stand the glass chamber in an inch of ice water. In about 15 minutes lift the chamber from the ice water and dry the outside and observe the water.

Where did the water go? What made the water disappear? What made it return?

39. Leading Question: What does heat do to air?

Materials: Balloon, coffee can, hot water

Procedure: Blow up a balloon until it almost fills a coffee can but may still be taken out and put back with ease. Run hot water over the side of the coffee can.

Help the children observe that heat has caused the air to expand and take up more room. (The molecules move faster when heated and therefore expand.)

40. Leading Question: How many different ways can we blow up a balloon?

Materials: Soda bottle, balloon, heat source, water, pan

Procedure: Blow up a balloon. Ask the children to tell what is in the balloon. (Air) Deflate the balloon. Stick the balloon on the end of the soda bottle. Place bottle in a pan of water and heat the water. Lead the children to discover that air expands when heated.

41. Leading Question: What does cold weather do to air?

Materials: Jar, elastic membrane, rubber band, cold source

Procedure: On a cold day (or in a refrigerator) place a jar outside. While the jar is still outside (about 10 minutes) close it off with an elastic membrane (part of a balloon, but not stretched). Then bring the jar into the room and the membrane should expand. Reverse the process, putting the membrane on while the jar is in the room and then place the jar in the cold. The membrane should be drawn into the jar.

42. Leading Question: Can air cool or warm things?

Materials: Glass jar and water

Procedure: Put a glass jar which is filled with water in the sunlight. Put another similar jar in a dark place. Have the children feel the difference in temperature after several hours.

Help the children understand that the sun warms the air and that air warms things.

Note to teacher: The air in an oven is heated and bakes things.
The air in a refrigerator cools things.
The sun is very hot; it warms the air.

43. Leading Question: How can we change ice?

Materials: Tray of ice cubes, candles, paper, paraffin

Procedure: Take a tray of ice cubes and add heat. Have children see that a change has taken place. Children can suggest other materials which are changed by heat. Try burning a candle, burning paper or melting paraffin to stimulate other ideas.

Note to teacher: Man benefits from this process because he can dispose of his trash.

NATURE OF MATTER

Changes in Matter

Grade 4

Molecular Theory

UNDERSTANDINGS TO BE DISCOVERED	RELATED ACTIVITIES
Matter exists in three states: solid, liquid, and gas.	2, 3, 5, 9, 10
Matter is composed of small particles called molecules.	1, 2, 6
A molecule is the smallest division of a compound keeping the same characteristics of that compound.	
All matter is made up of its own particular kind of molecules.	2, 3, 4, 7
Molecular motion determines the state of the matter.	
Speed of molecules is determined by changes with temperature.	1, 3, 4
Molecules attract each other.	2, 7
Molecules of a solid vibrate and hold their place.	8
Molecules of a liquid vibrate more rapidly and are no longer firmly attracted.	2, 6, 8
Molecules of a gas vibrate very rapidly and show little attraction.	3, 5, 9

NATURE OF MATTER

Changes in Matter

Grade 4

Physical and Chemical Change

UNDERSTANDINGS TO BE DISCOVERED	RELATED ACTIVITIES
When matter changes in form, energy is needed.	11, 13, 14, 15, 16, 20
Physical and chemical changes are taking place all the time.	11, 12, 15, 16, 17, 18. 20
In a physical change the structure of the molecule does not change.	11, 13, 15, 18, 19
In a chemical change the molecules do change as the atoms are rearranged to form other molecules.	12, 14, 17, 20
Heat energy is released by some physical and chemical changes.	12, 14, 17

NATURE OF MATTER

Changes in Matter

Grade 4

Compounds and Mixtures

UNDERSTANDINGS TO BE DISCOVERED	RELATED ACTIVITIES
All substances are chemicals.	
When two or more elements are combined (chemically united) to form a new substance, that substance is called a compound.	22, 25
A mixture is a substance composed of two or more elements not chemically united.	22, 29, 30
A mixture can be separated mechanically (filtering, heating, cooling).	22, 28, 30
Chemicals can either be acid, base, or salt.	27
Acids and bases can change the color of certain chemicals known as indicators.	23, 24
Chemists use various tests to identify materials.	21, 23, 26, 27, 29
Man's control of chemicals and physical change gives him many useful products.	21

NATURE OF MATTER

Changes in Matter

Grade 4

ACTIVITIES

1. Leading Question: How do we know molecules exist?

   Materials: India ink, water, microscope, microscope slide and cover, heat

   Procedure: Place a drop of water on the slide. Using a pen, place a very small amount of India ink in the drop of water and cover with a slide cover. Place the slide under the microscope and focus on the drop. How would you explain the zigzag motion of the black specks?

   Heat water and observe movement. Has the speed increased?

   Note to teacher: Scientists believe this motion is due to the bombardment of these pigment particles by the smaller invisible molecules.

2. Leading Question: Do molecules in a liquid move?

   Materials: Alcohol, microscope, microscope slide and candle

   Procedure: Rub a candle across a slide until the slide is coated with paraffin. Add a drop of alcohol to the slide. Observe the loose paraffin particles in the alcohol under the microscope.

   Note to teacher: The particles have a constant but random motion that cannot be predicted. It is called Brownian Movement. You are not observing individual molecules, but the result of invisible molecular motion.

3. Leading Question: How can we observe that molecules of gases move about freely?

   Materials: Amonia, flat dish or pie pan

   Procedure: Have the children close their eyes while you pour the ammonia into the flat dish. As the children detect the odor, have them raise their hand.

How long did it take for you to be able to smell the ammonia?

What caused the odor to travel throughout the room?

4. **Leading Question:** How can we observe that molecules in solids are affected by the presence of heat?

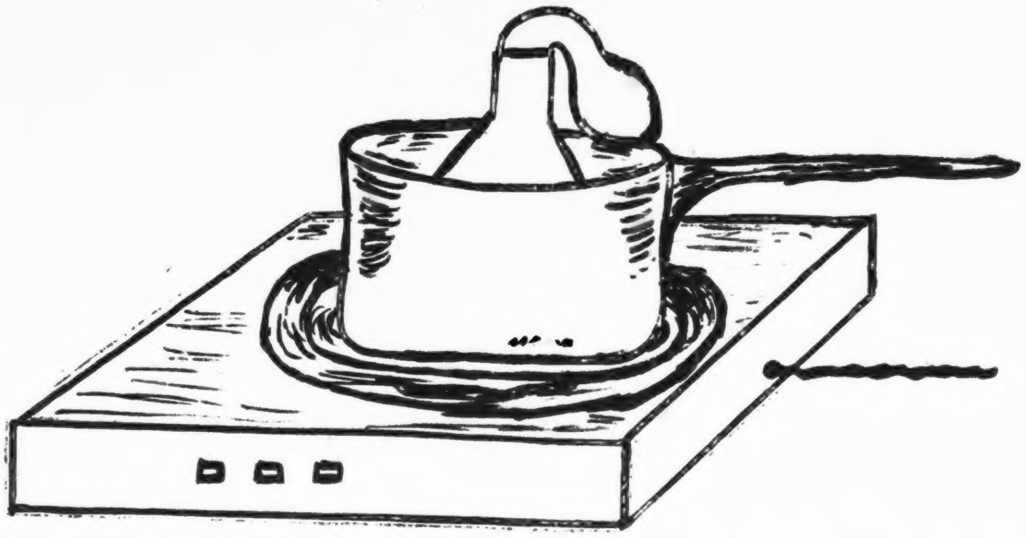
Materials: Ball and ring apparatus, alcohol burner

Procedure: Have a child demonstrate how easily the ball fits through the ring without the presence of heat. Using the alcohol burner have the child hold the ball over the flame for two or three minutes. The ball should now be hot enough to demonstrate that the ball will not fit through the ring. Explain.

5. **Leading Question:** How can we see a gas expand?

Materials: Electric hot plate, balloon, pan of water, Erlenmeyer flask

Procedure: Have a child put a balloon over the mouth of an Erlenmeyer flask, then place the flask in the pan of water on a hot plate. After the children observe what happens have them predict what will happen when the flask is placed in a pan of cold water.



6. Leading Question: Can we see the results of molecular motion in liquids?

Materials: Glass of water, vegetable coloring

Procedure: Allow the water to settle and remain as still as possible. Slowly add a drop of vegetable coloring. Without moving the mixture, observe what happens over a few days period.

What caused the water and coloring to mix?

7. Leading Question: How do we know that molecules of liquids attract each other?

Materials: Beakers (or baby food jars), water and other liquids, paper clips, needle, piece of tissue

A. Procedure: Distribute the beakers or jars to several groups of children. Fill the containers with a liquid. Drop the paper clips into the liquid one at a time and observe the top of the liquid. Does the liquid overflow or raise above the container? Repeat the activity using other liquids. What causes the liquid to hold together? Do all the liquids react the same? How do you explain a difference if any?

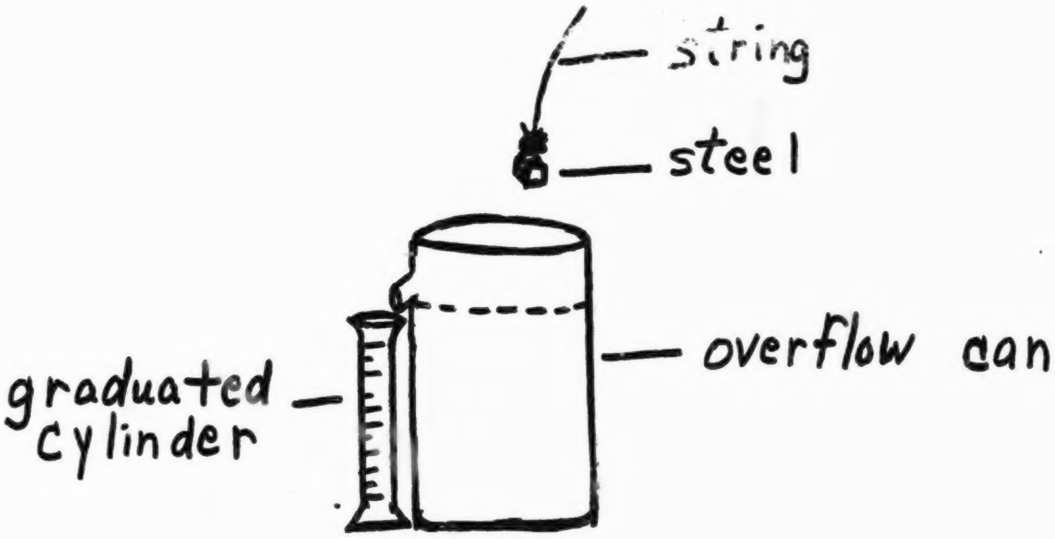
B. Procedure: Fill the container with water. Float a steel needle on a piece of tissue paper. (The tissue will get wet and sink, but the steel needle will float on the surface.) How do you explain what has happened?

Note to teacher: The children may want to try several liquids and record findings on a chart.

8. Leading Question: Can solids and liquids occupy the same space?

Materials: Overflow can, graduated cylinder, string, piece of rock, piece of steel

Procedure: Fill the overflow can to the overflow. Put the graduated cylinder under the spout. Using a string place the rock in the water until it is completely submerged. Measure the amount of overflowed water. Why did this water flow out of the spout? Repeat several times remembering to refill the overflow can before each test. Does the amount of water change or remain the same? Use the same procedure in measuring the space taken up by the piece of steel. Does the solid take up a definite amount of space?



9. Leading Question: How does an odor travel?

Materials: Shoe box, large onion, knife

Procedure: Cut the onion in half. Put one piece in a covered box and the other piece next to it. As the odor reaches the children ask them to raise their hands. Does everyone smell the onion at once? Does the smell travel bit by bit? Now open the shoe box, notice the stronger smell?

Note to teacher: Some of the molecules from the cut onion moved into the air. Diffusing out through the air, they reached the nearest noses first. The molecules of onion kept on traveling and even though the molecules are mixed with a room full of air molecules, you can still smell them a little.

10. Leading Question: What causes mothballs to decrease in size?

Materials: Mothballs, sealed container

Procedure: Weigh the mothballs on a trip balance scale and record weight. Place a mothball in a sealed container and in open areas around the room. Observe several days and weigh at various times.

What has happened to the mothballs? Are they decreasing in size? Why?

	Weight	Mon.	Tues.	Wed.	Thurs.	Fri.	Mon.
Sealed Container							
Open Area							

11. Leading Question: What is needed to produce a physical or chemical change?

Materials: Pieces of wood of different thicknesses, sheet of paper, old magazine, candle, matches

Procedure: Encourage the children to produce a physical change by breaking the thin wood, or tearing the sheet of paper. To show energy is needed, have several children try to break the thicker wood and tear the magazine. What is needed to produce this physical change?

Light the wood, paper and candle. Examine the chemical changes taking place. What was needed to produce this change? What do both activities show?

Note to teacher: In all cases some energy is required to produce the change. Care must be taken when burning materials in the classroom.

12. Leading Question: How can chemical changes help us? or harm us?

Materials: Piece of coal, coal ashes, wood, wood ashes

Procedure: Upon examination of the coal and wood, the children should be presented with questions such as; Why do we dig coal or cut trees? What happened to change this coal and wood to ashes? How could this help someone?

Note to teacher: Children should understand that the heat released during a chemical change is the main by-product of fuel.

13. Leading Question: When a material changes states or dissolves, is this a physical change?

A. Materials: Saltwater, clean pan, heat source

Procedure: Be sure your equipment is clean. Heat some saltwater in a clean pan until the liquid has evaporated. Taste what remains. What effect did heat have? Does salt dissolve faster in hot water than in cold?

Note to teacher: When a material dissolves it is a physical change, heat hastens process.

B. Materials: Beaker, ice cubes, thermometer, heat source

Procedure: Fill a beaker with ice cubes. Hang a thermometer in the beaker of ice cubes. (Do not touch bottom with thermometer.) Record the temperature.

Begin to heat ice cubes and record temperature when ice has just about melted. How do you account for the fact that there is no change in temperature even through you heated the ice?

14. **Leading Question:** Can you produce a chemical change with a match and a candle?

Materials: Clock or timer, candle, matches, ruler, pencil, candle holder

Procedure: Mark inches and half-inches on a candle with a pencil and ruler. Put the candle in a holder, light the candle and make a note of time.

Observe the burning candle. How long does it take for the first inch to burn? the second inch? What happens to the paraffin? What is needed to produce this change?

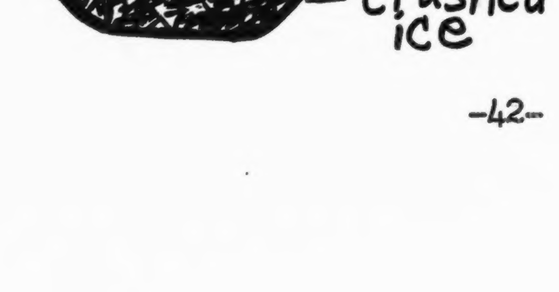
Note to teacher: Molecules of paraffin are changed to molecules of water and molecules of carbon dioxide. As this chemical change takes place light and heat are given off.

15. **Leading Question:** What is needed to change a material from one state to another?

Materials: Container to heat water, thermometer, heat sources, glass of ice

Procedure: Place a thermometer in the water, record temperature and begin heating the water. Record the temperature every thirty seconds until the water begins to boil. At what temperature did the water begin to boil? Does the temperature increase as the water boils more rapidly? What is happening to the amount of water?

Place a thermometer in the container of ice. Record the temperature and observations every minute. What have you observed about the states of matter and the temperature?



Time	9:00	9:01	9:02	9:03	9:04	9:05 -------
Temp.	32°	36°	42°	50°	70°	-------

16. **Leading Question:** What are we able to observe during changes of matter?

Materials: Cube of ice, cube of butter, cube of wax, cube of lead, cube of steel, containers for heating, heat source

Procedure: Arrange the materials around the room. Make observations and record findings. What material changed first, second, etc.? How long did it take to change state? Heat the materials that have not changed at room temperature. What have you observed about the different materials?

Material	Room Temp.	Temp. of Material	Time of Change	Temp. After Change	Remarks
Ice	72°	32°	6 min.	70°	Ice changed to water
Butter					
Wax					

17. **Leading Question:** What's the change?

Materials: One candleholder, one candle, tape, three dishes, one alcohol burner, one plastic tumbler

Procedure: Place the candle in the candleholder. Let a child measure the height of the candle with a ruler. Light the candle and let it burn. After a few minutes extinguish the flame. What has happened? Where did the wax substance go? (changed to invisible gases)

Extinguish the flame on the alcohol burner. Why is the level of the alcohol lower? (changed to gases that go into the air). The burning alcohol and candle are examples of chemical changes.

Light the candle again and tilt it over a lid, letting some of the wax drip onto the lid. What kind of change is this? (physical) The substance is still wax, although it has changed from a solid to a liquid.

The class should conclude burning is a chemical change.

Note to teacher: A lighted alcohol burner is to be left burning throughout this activity while other activities are going on. Remove all flammable material. Allow a child to place a label at the level of the alcohol at the start of the activity. Light the burner.

18. Leading Question: What evidence of chemical and physical change is present around the school?

Materials: Our environment

Procedure: Explore the playground and area around the school recording changes noted by the children. The children may continue to observe changes taking place around the home. They may also discuss ways of preventing change.

Object	Condition	Remarks
Nail	Painted	After one week we see no change
Wood	Plain or Untreated	After one week color is changing

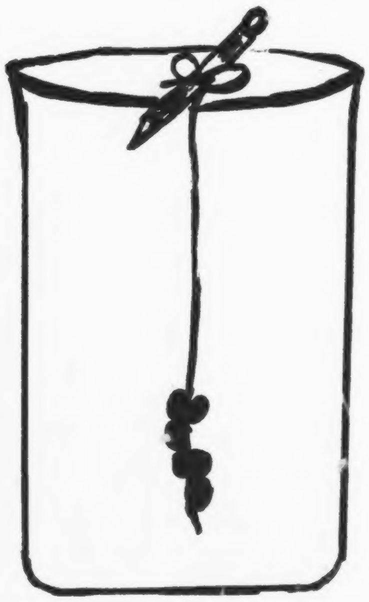
19. Leading Question: What is a physical change?

Materials: One 3/4 cup sugar, one cup of water, hot plate, beaker, string, pencil

Procedure: Place sugar in boiling water. Stir until sugar dissolves and allow the solutions to cool. When the solution cools, hang a piece of cotton string in it. Hold the string in position by tying it to a pencil placed across the top of the beaker.

In a few hours small crystals should form and if left undisturbed, the crystals will grow larger.

Examine the crystals under a stero microscope. Do the crystals look like sugar? How do you explain what happened?



20. **Leading Question:** How can we distinguish a chemical change from a physical change?

Materials: Salt, sugar, water, thin piece of wood, containers, heat source, stereo microscope

Procedure: Mix the salt and sugar. Examine the mixture under the stereo microscope. Note the changes, if any, in the crystals. Heat the sugar crystals and allow it to cool. Re-examine the mixture and again note change. What has caused the changes?

Have several groups of children repeat the procedure using pieces of wood or other materials suggested by the children or teacher. The groups should record findings and compare with findings of other groups.

Note to teacher: The children should examine the sugar and salt crystals under the stereo-microscope to recognize the shape of the crystals.

21. **Leading Question:** How can we make CO_2 (Carbon Dioxide) and test for it?

Materials: Limewater, medicine dropper, test tube, vinegar bicarbonate of soda, teaspoon, baking powder

Procedure: Encourage the children to make mixtures and test for the presence of Carbon Dioxide.

Suggested mixtures:

1. Four teaspoons of vinegar to one teaspoon of baking soda. Pour the foam (gas) into a test tube of limewater. Cover with a glass plate and shake.

2. One teaspoon of water to one teaspoon of baking powder. Follow procedure as in #1.

The children will think of additional mixtures to make.

Note to teacher: (The test for carbon dioxide (CO_2) is to place limewater in the gas, if the limewater turns a milky color, carbon dioxide is present.) Have the children research textbooks to discover this test.

22. **Leading Question:** What happens when elements combine?

Materials: Sulfur, iron filings, magnet, source of heat, large pyrex, test tube

Procedure: (Teacher Demonstration) Fill a test tube $\frac{1}{4}$ full with a mixture of iron and sulfur. Heat the test tube for about three minutes in a hot flame, in a well ventilated room.

Do not breathe the vapors. Do not point the test tube at anyone. Cool the test tube and remove the remaining substance. Test the substance with a magnet, and write down its properties.

Discuss with the class the properties of iron and sulfur and what happens when the chemicals are mixed and heated.

23. Leading Question: How can we test for starch?

Materials: Water, iodine, glass rods, medicine, materials to be tested

Procedure: If the materials to be tested is a solid, add a drop of iodine directly to the material. If, however, the material to be tested is a liquid, dilute the testing material and then add a drop of iodine.

Test the following materials and chart for Positive or Negative reaction:

cornstarch
potato
apple
bread
meat
oatmeal
banana
baking soda
coke
sugar
spaghetti
noodles
milk
egg white
popcorn
cheese
rice
cracker
butter
newspaper
writing paper
other materials desired

Material	Positive	Negative

Note to teacher: Encourage the children to research to discover the test for starch. The formation of a blue-black color when iodine is added, indicates the presence of a starch.

24. Leading Question: How can we identify organic from inorganic material?

Materials: Foil plate or pan, Bunsen burner or alcohol lamp, asbestos gloves

Procedure: In the foil pan heat the following items:

wood shavings
sugar
paper
flour
milk
baking soda
sand
salt
iron filings

Chart the results:

Test Item	Positive (Organic)	Negative (Inorganic)

Note to teacher: Have the children research to discover the basic difference between organic and inorganic materials. Materials that contain carbon are organic materials. If a sample turns brown or black when heated carbon is being released.

25. **Leading Question:** Can the level of water be reduced by adding another solution?

Materials: Two test tubes, stoppers, china marking crayon, rock salt, water, small pebbles

Procedure: Half fill each test tube with water. In the first test tube drop enough rock salt to raise the water level ½ inch. In the second test tube add enough small pebbles to raise the water level ½ inch. Mark the water level of each test tube with a china-marking crayon. Put the stopper on both test tubes and shake them until the salt is dissolved.

Compare the levels in both test tubes. Help the children explain the fact that the salt solution level is reduced.

Note to teacher: When the salt dissolves, its particles separate and go into some of the space between the molecules of water so the salt solution takes up less room than the salt and water did when they were still separate.

26. **Leading Question:** How can we test for oxygen?

A. Materials: Splint, test tube, match

Procedure: Light splint, blow out, place glowing splint into an "empty" test tube. Observe the glow.

B. **Materials:** Hydrogen peroxide, laundry bleach, cardboard, glowing splint and clamp

Procedure: Hold test tube with clamp. Fill a test tube $\frac{1}{4}$ full with hydrogen peroxide. To this solution add a few drops of laundry bleach, such as Clorox.

Observe the fizzing which indicates gas is being released. Cover the tube with cardboard to prevent the oxygen escaping. Hold a glowing splint in the test tube and observe the results.

How did the test seem to indicate the presence of oxygen?

Note to teacher: Oxygen supports combustion.

27. **Leading Question:** How can we test for acids and bases?

Materials: Test tubes, glass rods, red litmus paper, blue litmus paper, tests solutions (see below)

Procedure:

Blue litmus paper - turns red = acid
" " " - no change = test for base

Red litmus paper - turns blue = base
" " " - no change = test for acid

Test the following materials and chart results:

vinegar
hydrochloric acid
sugar water
limewater
salt dissolved in water
sour milk
ammonia
Epsom Salts in water
buttermilk
soap solution
alcohol
orange juice
mayonnaise
any other materials desired

ACIDS	BASES	NEITHER

28. Leading Question: Can you find the salt?

Materials: Six filters, salt, sand, magnifying glass, twelve tumblers, six containers, plastic spoons

Procedure: Group the children and place a small quantity of sand and salt into their containers and mix. Have the children observe the mixture through a magnifying glass and discuss ways in which the mixture could be separated.

Note to teacher: To separated mixture, add water and filter through filter paper into tumbler. Sand will remain in filter.

How can we remove the water? (heat - evaporate)

Additional Study: Mix various substances with water and observe what happens. For example:

sawdust - floats on water
powdered chalk - does not dissolve
oil - floats on water
sugar - dissolves in water

Other suggestions: coffee grounds, instant coffee, tea, bicarbonate of soda, dry milk, cocoa.

29. Leading Question: How can we test for fats?

Materials: Kraft paper, knife, light, radiator or heat source

Procedure: Fats in foods will leave a grease spot when placed on paper and warmed for five minutes. Hold the paper up to a light and examine for a translucent spot left by the oil.

Test these foods and then try others:

sugar
fat
butter
mayonnaise
peanut butter
olive oil
cheese
bread
lettuce
bacon
Crisco

Chart for positive or negative response.

Test Item	Positive	Negative

30. Leading Question: Can a mixture be separated?

Materials: Table salt, iron filings, magnet, plastic bag, small plastic dishes, stereo microscope or magnifying glass

Procedure: Separate the class into groups and in each group supply the necessary material. Allow the children to mix the salt and iron filings. What mixture do you have? Does the mixture look like either of the two substances? How can we separate each of the substances from the mixture?

Note to teacher: The class may use the stereo microscope or magnifying glass to examine the mixture, observe the two particles in the mixture.

Iron filings are very difficult to remove from a magnet, using the plastic bag makes it easier. Cover the magnet with the plastic bag before picking up the iron filings.

NATURE OF MATTER

Atoms and Molecules

Grade 6

Nature of the Molecule

UNDERSTANDINGS TO BE DISCOVERED	RELATED ACTIVITIES
Matter is the name given to everything that has weight and takes up space.	
All matter is structured of exceedingly small separate particles, called molecules, which are in ceaseless motion.	1, 2, 5, 6
Molecules are made of atoms linked together in definite combinations	
Molecules attract each other.	3, 4
An element is a substance composed of only one kind of atom.	
A solid has a definite shape and definite volume.	5, 9, 12
A liquid takes the shape of the container and has a definite volume.	6, 9, 12
A gas has no definite shape and expands indefinitely to fill the container.	2, 9
In a physical change, the composition of molecules is not changed.	6, 9, 10, 11 12
In chemical changes, the composition of molecules is altered. New materials are formed by the assembling of new combinations of atoms.	8, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24
Chemical changes involve a transfer of energy.	13, 16, 18, 27
Chemical changes play an important part in our lives.	8, 17, 20, 24, 28
Substance is any particular kind of matter, either element, compound or mixture.	10, 14, 25

UNDERSTANDINGS TO BE DISCOVERED (Cont'd.)	RELATED ACTIVITIES
An understanding of the behavior of substances enables the chemist to determine the identity of unknown substances.	8, 14, 24, 29, 30
Chemists have identified about 700,000 kinds of compounds.	4, 8
A compound may exist as a solid, a liquid, or a gas.	8, 14, 15, 24, 27
Compounds differ markedly in their properties from the elements of which they are composed.	14, 15, 17, 20, 24, 27
A mixture is a substance consisting of two or more elements or compounds that are not chemically united. (i.e. air, soil)	15, 25, 26
A solution is a mixture of two or more materials evenly mixed together whose particles are separate molecules.	10, 31, 32
A liquid with undissolved particles scattered in it is called a suspension.	33, 34
Acids are active compounds which contain hydrogen.	13, 35, 36, 37
Bases or alkalis are compounds which tame acids and make them helpless by turning them into ordinary water.	35, 37
Symbolic expressions are used in chemistry.	

NATURE OF MATTER

Atoms and Molecules Grade 6

Nature of the Atom

This phase of the unit is not applicable to all sixth grade classes in our schools; the involvement in depth of this area is dependent upon the nature of the class involved.

UNDERSTANDINGS TO BE DISCOVERED	RELATED ACTIVITIES
All substances upon the earth are made up of atoms which are ordinarily considered the smallest unit of matter.	39, 40, 44
Atoms are matter and contain energy.	
There are 92 different kinds of atoms.	44, 48
Protons are positively charged particles, electrons are negatively charged particles, and neutrons are particles which are neither positively nor negatively charged.	41, 46
By adding or subtracting protons or neutrons, scientists have learned how to change from one kind of atom into another kind of atom.	44, 46
The atomic number indicated the number of protons in the nucleus and the number of electrons in the orbits.	45
Atoms are weighed in units known as atomic weight.	48
Neutrons are effective "bullets" for the splitting of atoms.	43
In the splitting of an atom some of its matter is converted into energy.	
Matter can become energy--energy can become matter.	51
The splitting, or fission, of an atom results in the formation of new kinds of atoms and the release of energy.	42, 43
The destruction of a tiny amount of matter results in the liberation of an enormous amount of energy, as indicated in the equation $E=MC^2$.	
In a chain reaction each splitting atom releases energy, as well as neutrons for the splitting of more atoms.	

UNDERSTANDINGS TO BE DISCOVERED (Cont'd.)	RELATED ACTIVITIES
The energy produced by atomic reactors and atom bombs comes from a chain reaction of atoms undergoing fission.	43
In the hydrogen bomb, hydrogen atoms join to form helium atoms causing fusion in contrast to the fission that occurs in the atom bomb.	
Some atoms, such as those of radium and uranium, split spontaneously; they possess natural radioactivity.	43, 47, 50, 52
Atoms can be made radioactive by bombardment with nuclear particles in the atomic pile or in "atom smashers."	49
Scientists have synthesized new atoms heavier than uranium.	48
These atoms, called radioactive isotopes, are useful in the fields of medicine, agriculture, and industry.	47, 50, 52
The energy of atoms has a potential for good or evil for mankind.	49

NATURE OF MATTER

Atoms and Molecules

Grade 6

ACTIVITIES

1. Leading Question: Do gas molecules move about freely?

   Materials: Household ammonia, flat dish

   Procedure: Have a student stand at one end of the room, while another student stands at the other end of the room. Have one of these students pour a little household ammonia into the flat dish. The class should record the time necessary for the odor of the ammonia to reach the student at the opposite end of the room.

   Help the children to understand that the molecules of ammonia mix with the molecules of air and move freely throughout the room.

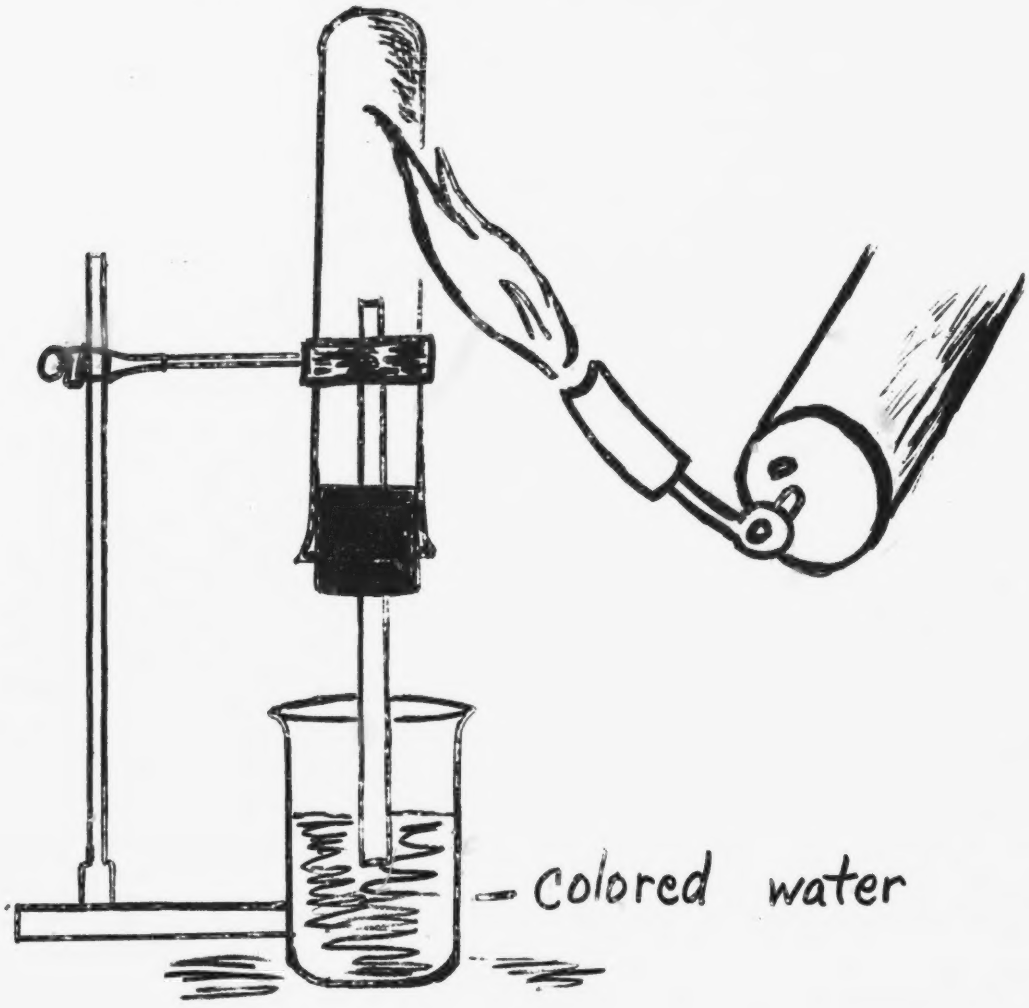
   CAUTION: Ammonia should not be inhaled directly. Hold any material to be smelled at a distance and fan the air with the hand to bring the smell to the nose.

2. Leading Question: How do heating and cooling change the volume of air?

   Materials: Open flame, ring stand, test tube, stopper, glass tube, beaker, water

   Procedure: Set up the experiment as illustrated. Apply heat to the test tube. Note that the heat expands the air in the test tube, forcing air (seen as bubbles) down the tube and through the water. When the heat is removed, water should rise in the tube.

   Have the children predict what might happen before the heat is applied to the test tube. Have them predict what will happen when the heat is removed before the heat is actually removed.



3. Leading Question: Do molecules attract each other?

Materials: Microscope slide, glass tumbler

Procedure: Clean microscope slide very carefully with soap and water and dry it off.

Dip the slide into a glass of water, and then remove it.

Observe the droplets of water on the glass slide. Does the water remain on the slide? Is it all in one pool or made up of individual drops? Do water and glass seem to attract one another?

4. Leading Question: Will molecules attract?

Materials: Microscope slide, thread, saucer, easy-to-stretch soft spring ruler, alcohol, oil, mercury

Procedure: Wash and dry a microscope slide. Tie a thread around the center of the slide so that it will hang perfectly level, with its flat surface facing downward.

Slowly lower the slide until its flat surface just touches the surface of the water in a saucer.

Lift threads gently and slowly. Let the class feel the pull on the thread.

Then attach a very soft easy-to-stretch spring to the end of the thread. Repeat the experiment and ask someone to stand a ruler on the table next to the saucer and measure how far the spring must stretch before the slide leaves the water.

Try the same thing with alcohol, oil and other liquids. Does the spring stretch any further with one liquid than another? Why do you think the spring stretches at all?

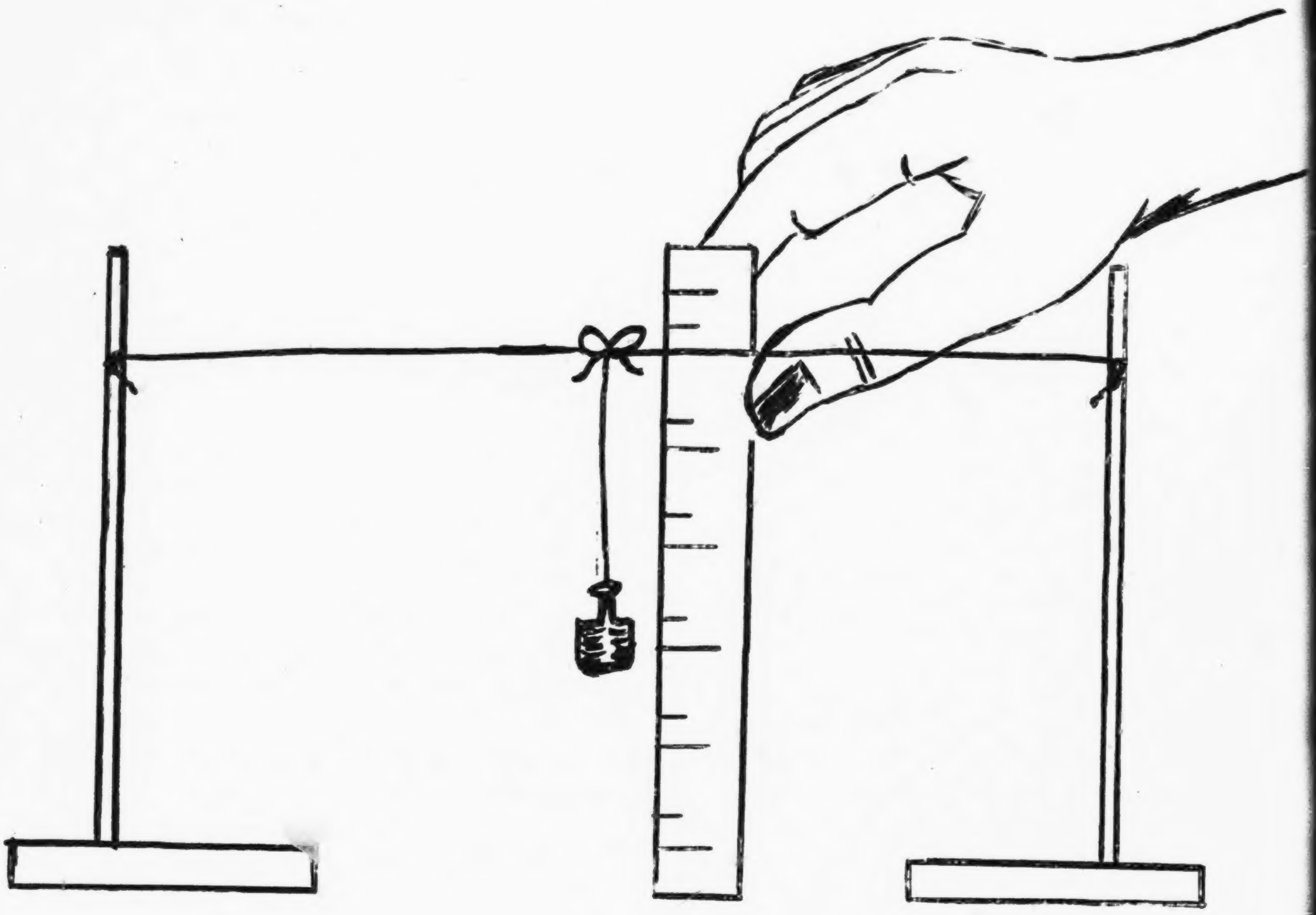
Note to teacher: The spring stretches because it must overcome the attraction between the glass molecules and the molecules of the liquid being tested.

5. Leading Question: How do heating and cooling change the length of a wire?

Materials: Wire, weight, ruler, 2 ring stands, piece of string

Procedure: Connect a wire extending from one ring stand to another as shown in the illustration. Tie a weight to a piece of string and suspend from the center of the wire. Use the ruler to show the distance of the weight from the table. Place a gas burner under the wire and move it back and forth to heat.

Have students observe the changes in the wire when it is heated, and then observe the cooling state of the wire.



6. **Leading Question:** How can we change the volume of water?

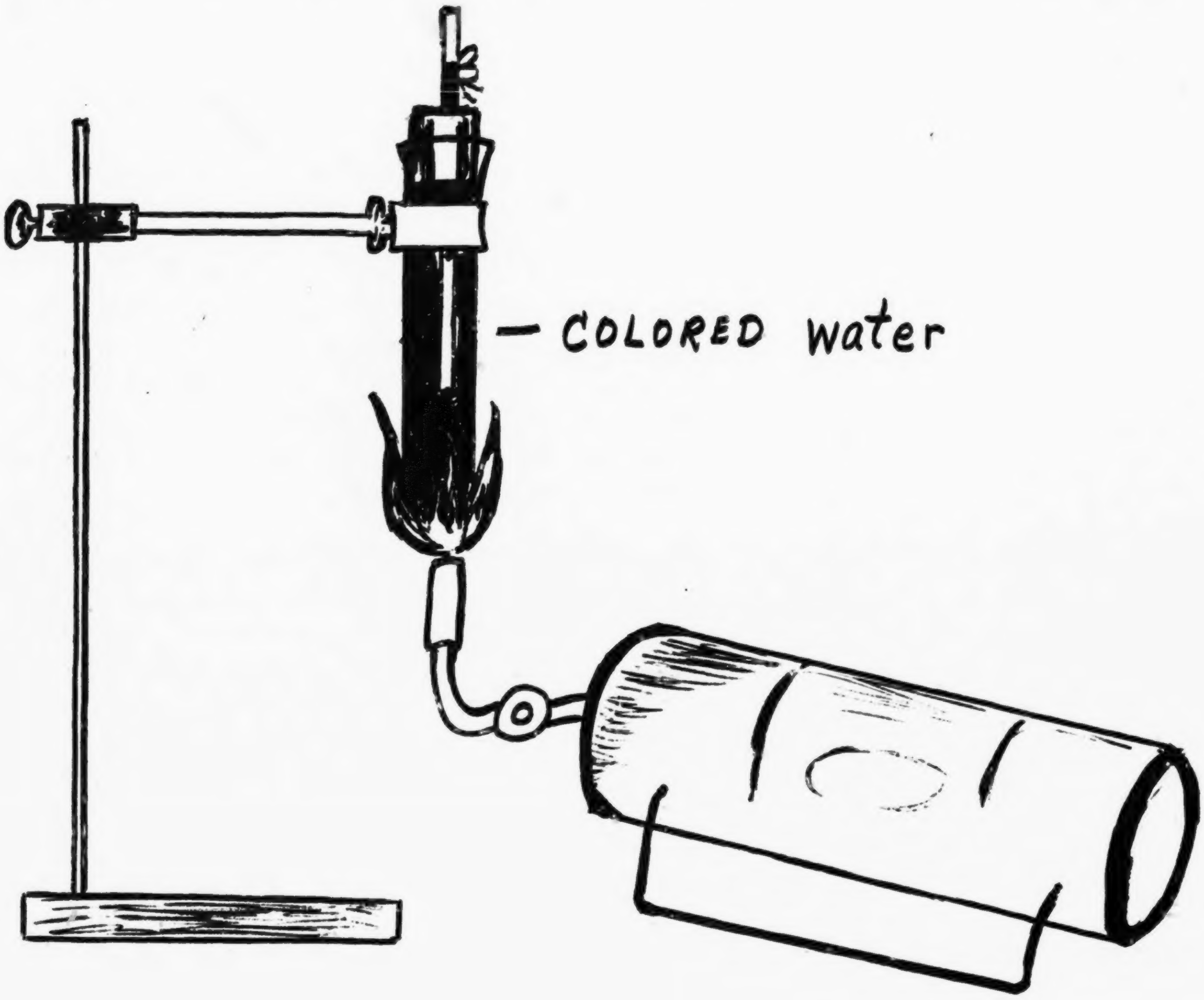
Materials: Ring stand, clamps, heat source (open flame), test tube, stopper, string, colored water in beaker, glass tube

Procedure: Discuss with the class, the effects of heat on materials. Lead the children to respond that heat causes matter to expand.

Present the materials listed to two groups of students. Ask them to devise an experiment to show that heat will change the volume of water.

Have two groups present their experiment to the class and discuss the reasons for any differences noted.

Note to teacher: The following illustration is given for your information only. Be careful to see that a very long glass tube is used as heated water will rise quickly.



7. **Leading Question:** What are some common compounds we use everyday?

Materials: Compounds brought in by class from home

Procedure: Have the children bring in common compounds such as salt, sugar, baking soda, vinegar and water. These should then be classified as to acid, salt, and base. Research these compounds and display them with their chemical formula.

Classify these materials in other ways:

(a) gas, liquid, solid
(b) texture

Note to teacher: All acids will contain hydrogen.

8. **Leading Question:** How can we make carbon dioxide?

Materials: Three small beakers or glasses, two tablespoonsful of baking soda, vinegar, water, matches

Procedure: Use three small beakers. In one of them put two tablespoonsful of baking soda. Fill another one-fourth full of water. Light a match and hold it into each of the beakers, one after the other. The children will notice that the match continues to burn as long as there is enough of it to burn.

Now pour one-half of the water into the beaker of vinegar and the other half into the beaker of soda. Again light a match and hold it into the beaker of soda water and the beaker of vinegar water. Again the match continues to burn in each of them.

Pour the vinegar water into the soda water and notice what happens. Light a match and hold it into the beaker of vinegar soda water. This time the match goes out, you notice a lot of bubbles when the vinegar water was poured into the soda water. These bubbles were bubbles of carbon dioxide. The carbon dioxide held oxygen away from the flame and a flame cannot burn without oxygen. This is one way to make carbon dioxide.

9. **Leading Question:** How do the three states of matter differ?

Materials: Pencil, book, ink bottle, ruler, several containers of the same size but different shapes, pint jar, basketball, air pump, water, ink for coloring water

Procedure: Divide the class into three groups. The first group should squeeze a pencil, a book, an ink bottle and a ruler to determine whether there are any changes in shape or size. This group should then establish two facts which are true of all solids.

Have the second group demonstrate that liquids take the shape of their container by placing a small amount of water into several containers of the same size but of different shapes. Then ask this group to measure out a half-pint of ink-colored water. Pour it into a pint jar.

Have the children observe how much of the pint jar is filled by the water. Is its size the same (half-pint)? Two facts should be established concerning liquids.

The third group should pump air into a basketball to show that a large volume of air can be forced into a small space. Count the number of "pumpsful" of air forced into it. Can this be done with a liquid? Why not? Let the air out of the basketball. Grab for it with your fingers. Does it have shape? Can you mold it into anything?

The students could prepare a chart on their findings.

Takes up Space	Has Weight	Has shape of its own	Has no shape of its own	Has definite size	Has no definite size
SOLIDS	SOLIDS	SOLIDS		SOLIDS	
LIQUIDS	LIQUIDS		LIQUIDS	LIQUIDS	
GASES	GASES		GASES		GASES

10. **Leading Question:** Do we ever get a chemical change when a liquid and solid are mixed?

Materials: Salt, sugar, alcohol, mossy zinc, vinegar

Procedure: Have the children mix various materials. Chart the results of each mixture. Discuss which mixture caused a chemical change. Lead the children to the conclusion that there are bubbles of hydrogen in the mixture of vinegar and mossy zinc.

For individual research: Have some students do research and find other materials which will produce a release of hydrogen.

Note to teacher: All acids contain hydrogen.

11. **Leading Question:** Do all solid substances become liquids before becoming gases?

Materials: Paradichlorobenzene (moth crystals), 2 jars, black paper

Procedure: Place a layer of moth crystals in the bottom of a jar, and close the top tightly. Read the label on the box to make sure you have the right chemical.

Place the jar in a sunny window.

Set up another jar in the same way, and tape black paper to one side of the jar.

Place the jar in the sunny window with the black paper turned toward the sun.

Have children predict the outcome. Then after 25 minutes, observe what has taken place.

12. Leading Question: Can matter change from one form to another?

Materials: Moth balls, test tube, test tube holder, propane burner, two glasses of water, paraffin wax, old pot, hot plate, eye dropper

Procedure: After a discussion of three states of matter present the materials to two groups of students.

The first group will heat the paraffin in an old pot on a hot plate. Fill an eye dropper with the results and immerse it in water. Then allow the wax to cool in the pot. Have the group predict what changes will take place and then observe changes that occur.

The second group will heat moth balls in a test tube. Drop the results into a glass of water. Also have children predict the results beforhand and then observe the changes.

13. Leading Question: Why doesn't all material mix?

Materials: Various materials to test such as lighter fluid, turpentine, alcohol, salad oil, water, paint, tempra, salt, flour, sugar, beakers or small glass jars

Procedure: Have the children experiment by mixing the different items listed. Chart the results and compare. Lead the children to observe that some materials when added to each other produce mixtures, some produce suspensions, and some produce solutions. Work in pairs and stimulate critical thinking when comparing results.

14. **Leading Question:** Can you separate (decompose) a chemical into elements?

Materials: Mercuric-oxide powder, test tube, stopper, open flame, wooden splint, small dish

A. Procedure: Pour not more than 1/8 teaspoonful of mercuric-oxide powder into the test tube. Put the stopper in the mouth of the tube. Then support the test tube just over the blue part of the burner flame. After a minute or two, look at the side of the tube about halfway up. What do you see?

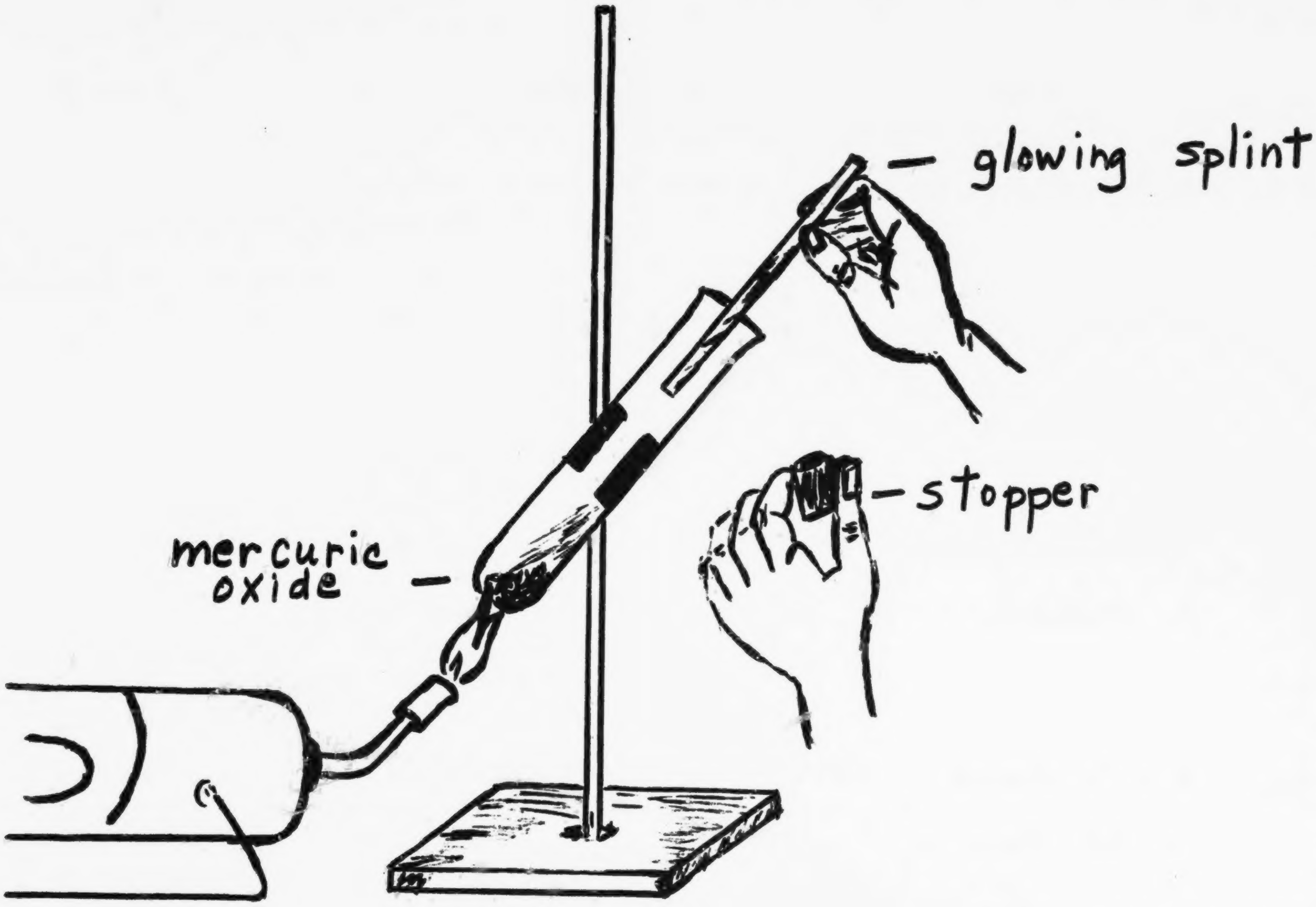
Note to teacher: Mercuric oxide poisonous--handle carefully.

B. Procedure: Light a wood splint and let it burn a little. Then blow out the flame. Quickly remove the stopper and plunge the glowing splint into the test tube. What happens?

Note to teacher: The splint will burst into flame.

C. Procedure: Put the stopper in and heat the test tube until all of the mercuric-oxide powder is gone. Again plunge a glowing splint into the test tube. What happens this time?

Now use a splint to scrape together some of the silvery material in the test tube. Pour it into a small dish. What is the material? Do you think mercuric oxide is an element or a compound? Explain.



15. **Leading Question:** Are there differences in the ways elements can be combined?

Materials: Balance, sulphur, iron filings, old spoon, matchstick or wooden splint, magnet

Procedure: Have the children place 1 gm. of sulphur and 1 gm. of iron filings in an old spoon. Mix the two substances together with a match stick or wood splint. Can the parts be separated? Will a magnet remove the iron filings from the sulphur?

Now heat the two substances gently in the spoon, but do not allow the sulphur to catch fire. As you continue to heat, what happens to the iron and sulphur? Is there any difference in the ease with which you can separate them? Would you say that the two elements have been conbined in a way that is different from the combination in Step 1?

16. **Leading Question:** Can chemical changes generate heat?

Materials: Graduated cylinder, vinegar, two test tubes, thermometer, balance, (sodium carbonate or sodium bicarbonate)

A. Procedure: Select a group of students to measure the temperatures of--a test tube containing 5 ml. of vinegar, a test tube containing 10 ml. of water, 1 gm. of dry sodium carbonate of sodium bicarbonate on a piece of paper. Record the findings on paper.

Place the thermometer in the water, and then add the sodium carbonate or sodium bicarbonate. Do not shake the mixture. Is there a change in temperature? Raise and lower the thermometer in the tube. Do the readings vary?

Wash off thermometer thoroughly, and place it in vinegar. Add the carbonate solution to the vinegar. Can you observe any change in temperature as the reaction takes place? If there is a change, can you feel the difference in temperature with your hands?

B. Procedure: Have a group of children put a test tube containing 10 ml. of water in a small glass tumbler or beaker $\frac{1}{4}$ full of water. Place a thermometer in the tumbler, and be sure the thermometer bulb is not touching sides of the tumbler.

Add 1 gm. of sodium carbonate or sodium bicarbonate to the water in the test tube. Observe the temperature of water in the tumbler. Is there any evidence that heat is not lost, but only transferred?

17. **Leading Question:** What gases are heavier than air?

Materials: Candle, vinegar, baking soda, matches, Erlenmeyer flask

Procedure: Have some children demonstrate the fact that some gases are heavier than others by performing the following experiment:

In an Erlenmeyer flask mix 2 teaspoons of baking soda and a little vinegar. Tilt the flask over a lighted candle and allow the gas (carbon dioxide) which results from the mixture to "pour" over the flame. There should be enough CO_2 (carbon dioxide) in the flask to put out the candle.

18. Leading Question: Can chemical changes absorb heat?

Materials: Cylinder test tube, thermometer, balance, salt

Procedure: Put 10 ml of water in test tube. Measure the temperature of the water.

Add 1 gm. of table salt to the water. Measure the temperature of the mixture. Does salt seem to give off or absorb heat as it goes into solution?

19. Leading Question: What chemical change can we produce with wood?

Materials: Tin can with tight lid, wood shavings, hot plate

Procedure: Have a group of students put some wood shavings in a tin can. Put the tin can on a hot plate and heat. The tin can should have a small nail hole punched in it to allow gases to escape.

The escaping gases can be lighted with a match and these will burn above the can as the wood shavings are heated.

In about 10-20 minutes, the can may be opened and the wood can be examined as charcoal.

20. Leading Question: How can we make alcohol?

Materials: Sugar, yeast, warm water, teaspoon, beaker

Procedure: Dissolve a teaspoon of sugar in about $\frac{1}{4}$ glass of lukewarm water. Crumble a cake of yeast into the water. Within a half hour a spongy mass of bubbles should form. The alcohol is the liquid below.

Note to teacher: The bubbles consist of carbon dioxide which is set free when sugar is changed into alcohol.

21. Leading Question: Will sugar burn?

Materials: Hot plate, sugar, small can, pie pan

Procedure: Into a pie plate on a hot plate, place a small can with sugar in it. Observe the chemical change that takes place. Have the children decide what the substance (carbon) is.

Note to teacher: Perform the experiment near an open window as the sugar will smoke badly.

22. Leading Question: Why does silver tarnish?

Materials: Hardboiled egg, mayonnaise, tomatoes, three silver plated spoons

Procedure: On each of the three spoons put a different tarnish-producing material: egg yolk, mayonnaise, chopped raw tomato.

Allow these spoons to set for a day. Observe the results. Try other foods.

Note to teacher: Spoons should tarnish due to a chemical reaction between the acids in the foods, the air and the silver.

23. Leading Question: Why are iron objects painted?

Materials: Two iron nails, house paint and brush, jar, jar cover, water

Procedure: Get two identical large iron nails and paint one with any kind of house paint. Do not paint the other nail. Stand both nails in a jar containing a little water and cover the jar, so that air in it will remain moist. When, after a few days, you examine both nails, you will discover a chemical change. What kind of chemical change? What happened to the nails? Describe the appearance of both nails.

Several students could be assigned to work the above activity and substitute aluminum nails, brass nails, screws and other metals.

24. Leading Question: How do we know that we exhale carbon dioxide?

Materials: Test tube, limewater, straw

Procedure: Fill a test tube about three-fourths full of limewater. Put a straw in the limewater. Take the other end of the straw in your mouth and blow your breath into the limewater. You will notice that it has turned a milky color. Carbon dioxide always turns limewater milky. We say that limewater is a test for carbon dioxide.

Note to teacher: This is the classic test for carbon dioxide.

25. Leading Question: What materials are mixed together in soil?

Materials: Garden soil, quart jar, water

Procedure: Pour several handfuls of ordinary garden soil into a quart jar so that it is about half full. Fill the jar with water. Screw the lid on tightly and shake the jar as strongly as you can. Let the jar stand overnight.

Examine the contents of the jar. Are all of the particles alike? What layer is on the top? On the bottom? Answer the question of the experiment.

Try this experiment with soil from different places. Do the samples all contain the same materials? How do you know that soil is not a compound?

26. Leading Question: What is the volume of oxygen found in the air?

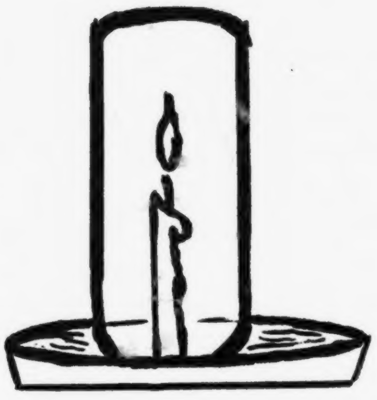
Materials: Metal or glass tray, graduated cylinder, liter jar, glass plate, candle, food coloring

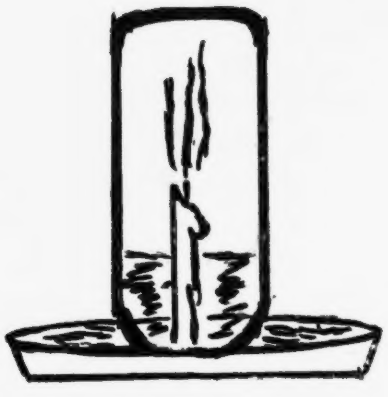
Procedure: Two able students can very easily prepare and demonstrate this activity.

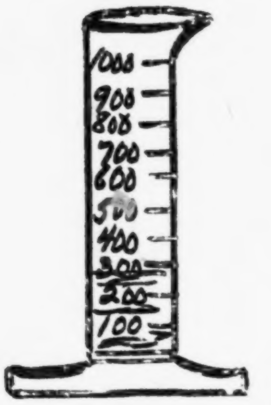
Melt some wax from a candle into the bottom of the tray and attach the candle to the melted wax. Fill the tray about 1/3 full of water and then light the candle. Take the liter jar (1000 ml) and place over the candle and submerge the jar into the water.

When the flame is extinguished, water will rise in the jar displacing the used up oxygen. Place a glass plate over the mouth of the liter jar while still submerged. Measure the amount of water which has rushed into the jar by using a graduated cylinder.

Note to teacher: The amount of water collected in the liter jar represents the volume of oxygen per liter.







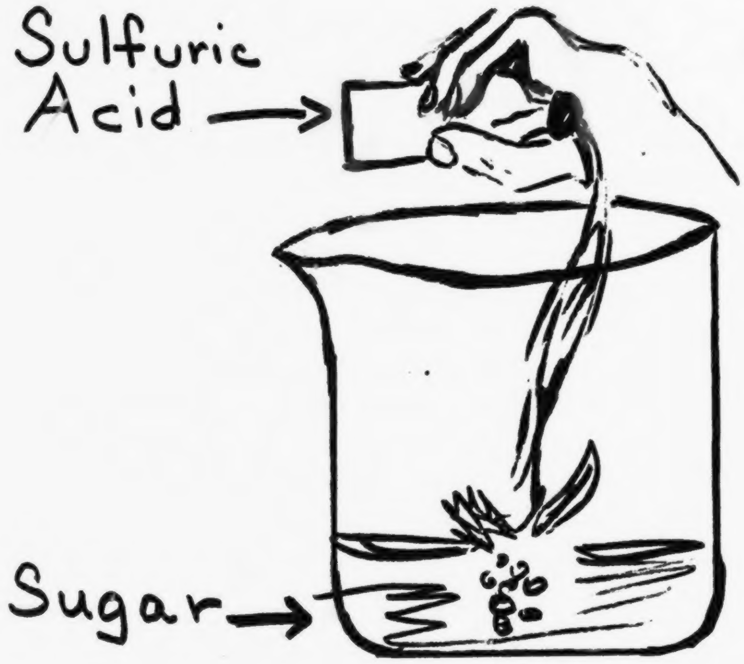
27. **Leading Question:** How can we decompose sugar?

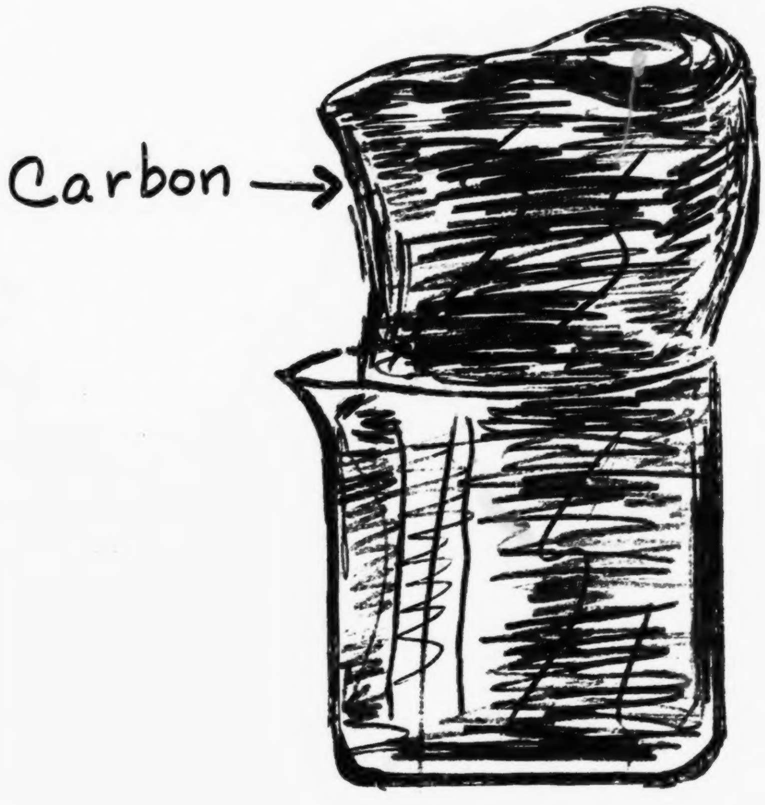
Materials: Large beaker, ordinary sugar, concentrated sulfuric acid

Procedure: Put four tablespoonsful of ordinary sugar into a 250 ml. beaker. Add sufficient concentrated sulfuric acid to thoroughly wet the sugar. After the reaction occurs discuss the evidences of a chemical change, including the heat produced by the reaction.

Note to teacher: Use extreme caution in handling sulfuric acid and disposing of black mass of pourous carbon that results.

The acid removes water from the sugar and leaves carbon which swells to an enormous volume because of the gas bubbles. Note that heat is released as a result of the reaction.





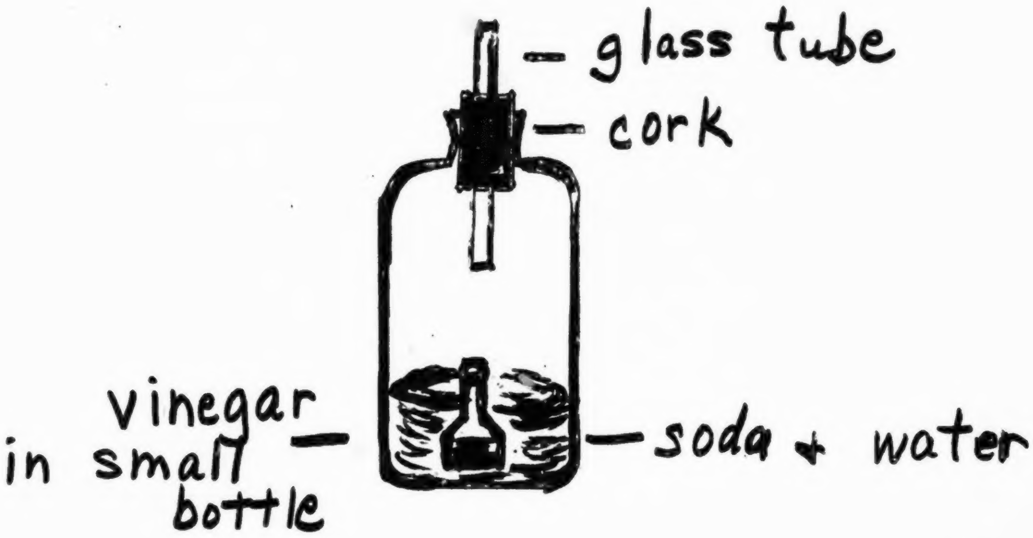
28. **Leading Question:** Can you make a fire extinguisher?

Materials: Pint milk bottle, cork, glass tube, soda, vinegar

Procedure: Use a pint milk bottle. Put a hole in the cork for glass tube; pour $\frac{1}{2}$ cup of water into bottle, add several tablespoons of soda. Stand a small bottle of vinegar in the large bottle. Fit cork.

Make a small fire on metal tray. Quickly turn bottle upside down-- hold cork with fingers and pointing tube toward fire.

Vinegar and soda will mix and form carbon dioxide. Carbon dioxide will push out through the tube and put out fire.



29. **Leading Question:** Can some elements be identified by color when exposed to a flame?

Materials: Open flame, wooden splint, table salt, cream of tartar, boric acid

Procedure: Moisten the clean end of a wooden splint and dip it into table salt, so that the crystals cling to it. Hold the end with the salt on it in the flame and notice the bright yellow color that appears. This yellow, which is deeper than that of a candle flame, tells the chemist that the element sodium is present. (TABLE SALT - SODIUM + CHLORINE)

Using a fresh splint, put some cream of tarter into the gas flame. Tiny reddish sparks stream off the match. This red color identified the element potassium.

Place boric acid on a splint under the flame. The green color given to the flame tells us that an element called boron is part of the compound known as boric acid.

30. Leading Question: How can we identify powders all having the same physical appearance, as observed by the naked eye?

Materials: Propane burner, test tubes, holders, paper cups, include mystery powders and all materials mentioned in tests below

Procedure:

Mystery Powders — Test

1. Granulated Sugar ------- heat makes sugar melt, bubble and turn black
2. Baking Soda ------------ vinegar causes it to fizz
3. Powdered Laundry Starch- or Corn Starch iodine turns starch black
4. Plaster of Paris ------- add water and should harden
5. Boric Acid------------- turns blue litmus paper red

Label the five Mystery Powders by letter A, B, C, D, E and have children discover the nature of the powder by performing the above mentioned tests. Children should record observations and test results.

What are the Mystery Powders?

Powder Number	What I think it is	Why I think so
A		
B		
C		
D		
E		

31. Leading Question: What is a solution?

Materials: Sugar salt, mud, red ink, and test tubes

Note to teacher: Solution is when particles of a solid, a gas, or a liquid mingle with the particles of a fluid--such as water so completely that a uniform liquid results.

Procedure: First mix sugar or salt in test tube with water. Make sure it is dissolved.

Then mix in another test tube mud or red ink. Compare the results with first test tube. How are they different?

Note to teacher: If any particles are large enough to be seen, the mixture is not in solution.

32. Leading Question: What are the characteristics of a liquid solution?

Materials: Tea, glass, hot water, filter paper and test tube

Procedure: Place a teaspoonful of tea leaves in a glass--pour hot water over them.

Notice how the water changes color--immediately or slowly?

Fold filter paper and place in funnel. Place funnel in test tube. Pour tea solution through funnel.

Examine filtered liquid in test tube. Is it colored? Taste--is there a tea taste? Is there any color to the solution? Can you see any tea particles?

Let test tube of tea solution stand for a few days. Repeat the above test.

33. Leading Question: Can suspensions be cleared chemically?

Materials: Five test tubes, soil, balance, graduated cylinder, aluminum sulfate, salt, sulphur, limewater, strong light, milk

Procedure: Mix a pinch of soil with $\frac{1}{2}$ test tube of water. Shake the mixture until the water becomes cloudy with suspended material.

In another test tube, mix 1 gm. of aluminum sulfate with 10 ml. of water. Shake to dissolve it. Add twenty drops of the aluminum sulfate solution to the tube of soil and water.

Now repeat Steps 1, 2, and 3, using sulphur instead of aluminum sulfate.

To each tube of soil, water and chemical, (aluminum sulfate, table salt, and sulphur) add 40 drops of limewater. Hold tube up to a strong light as you add the limewater to observe whether or not anything unusual is happening.

Help the children conclude from this experiment that some chemicals have the ability to purify water.

If one of the mixtures became clear after you added the chemical and the limewater, repeat the process with the same chemical and the limewater, but using milk instead of soil and water. Milk is one of a special group of substances called colloidal dispersions. Does this chemical seem to be useful for clearing colloidal dispersions?

34. **Leading Question:** What happens when oil is mixed with water?

Materials: Lubricating oil, water, test tube

Procedure: Fill a test tube half full of water. Add about ½ inch of lubricating oil. Is the oil soluble in water?

Cover the mouth of the test tube with your thumb and shake it as strongly as you can. What happens?

Let the mixture stand awhile. What happens to the mixture?

35. **Leading Question:** How do we test for acids and bases?

Materials: Litmus paper, vinegar, water, lemon juice sweet milk and liquid soap

Procedure: Litmus paper is used to test for acids and for bases. Get a small amount of each of the following--vinegar, water, lemon juice, sweet milk and liquid soap. Select five pieces of blue litmus paper. Put the end of each of these papers into each of the liquids and remove them again. Notice what happens.

The vinegar and lemon juice caused them to turn pink. The other three remained the same. Blue litmus can be used to test for acids. It turns pink when acid is present.

Select five pieces of pink litmus paper and test each of the liquids in the same way. Here you notice only one of them changed. The one with the soap on it turned blue. Liquid soap is a base. Bases turn pink litmus blue. The other liquids, milk and water, changed the color of neither paper because they were neither acids nor bases.

Note to teacher: Some suggested solutions for test are:

Sugar water
Salt water
Limewater
Milk
Sour milk
Ammonia
Solution of soap
Alcohol
Mayonnaise

36. **Leading Question:** What can we use at home to determine whether solutions are acid or basic?

Materials: Red cabbage, water, baking soda, vinegar

Procedure: Divide your students into two groups. The first group will chop up half a glassful of red cabbage, add a glass of water and bring the mixture to a boil. Simmer for 15 minutes and pour off red liquid to cool. Pour a little of the red cabbage juice into a test tube and add a pinch of baking soda (base). The color should change from wine red to deep green. Add vinegar (acid) little by little until the liquid changes back to red color. Use cabbage juice to test other acids or bases.

The second group may experiment with the juices of cherries, rhubarb, blueberries, blackberries or elderberries. Crush the fruit to extract the juice. Squeeze out as much juice as possible. Soak soft white paper in the colored juice, letting the paper soak as much of the juice as possible. Lay the paper in a shady place to dry. Use the paper as an indicator for acids or bases.

37. **Leading Question:** How can we test a mixture to see whether it has more acid or more base?

Materials: Pan, water, glass of shredded red cabbage, hot plate or open flame, baking soda, vinegar

Procedure: Have a group of children put a glassful of water in a pan. Add half a glass of shredded red cabbage and bring it to a boil. Turn down the flame and let the mixture simmer for fifteen minutes. Pour the colored water into a glass and let it cool. Then put some of the liquid into a saucer, add one-quarter teaspoonful of baking soda and stir. The color will change from wine-red to a deep green. Children should discover that the baking soda made the mixture basic. Now add vinegar little by little, stirring the liquid. At a certain point the color will turn red again, showing that the mixture is now acid. Compare the results and the colors! Have the children make a chart of the results.

38. **Leading Question:** What are the parts of the atom?

A. Materials: Modeling clay, beads, small balls, wires, pipe cleaners, Tinker Toy or similar construction sets

Procedure: Have children construct simple models of various elements using the above material referring to the following table.

Number of particles in the Atoms of some elements

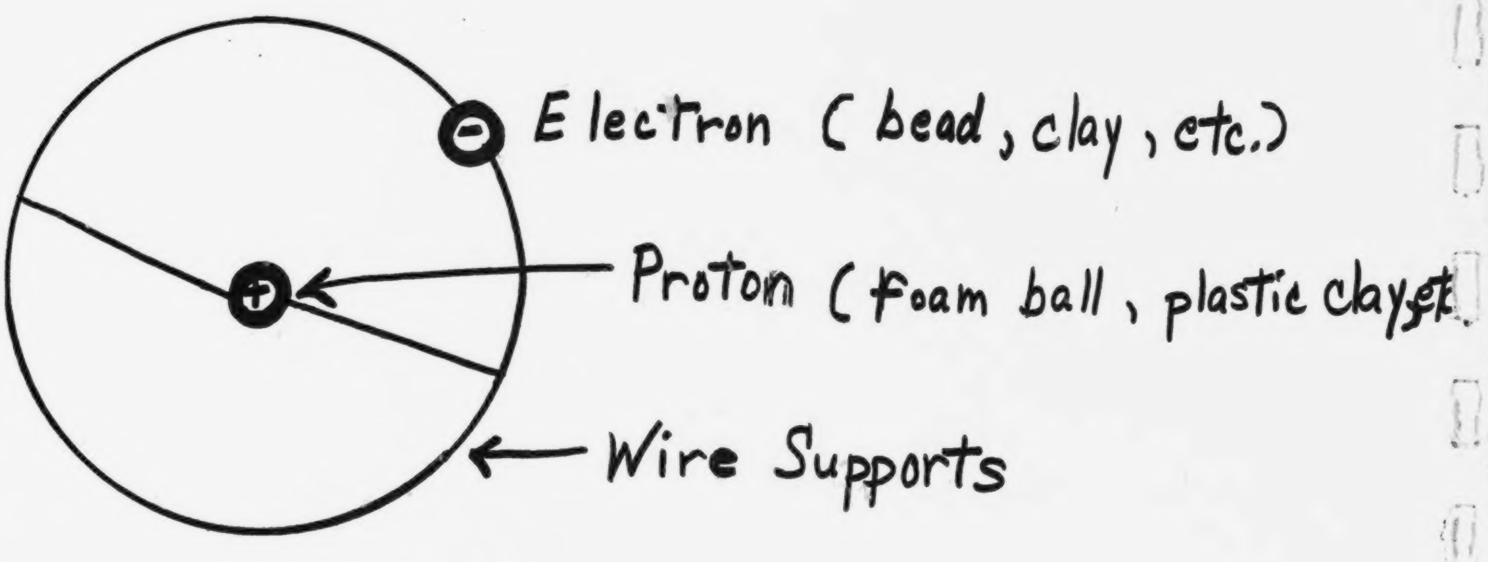
Element	Proton	Neutron	Electron
Hydrogen	1	0	1
Helium	2	2	2
Lithium	3	3	2
Carbon	6	6	2

Discuss how differences in the various models might be shown in models by color, labels and varying size.

Protons and neutrons should be shown close together and the same size. Electrons should be noticeably smaller than particles in the nucleus.

Example:

HYDROGEN - I


Electron (bead, clay, etc.)
Proton (foam ball, plastic clay etc.
Wire Supports

	B. Materials:	Central Science Materials Library
	Procedure:	Molecular Model Kit --- Construct various models of molecules through the use of different colored atoms contained in molecular model kit.
	Note to teacher:	Explain to children that these are only models that represent structure and not true appearances.
39.	Leading Question:	What is an atom?
	Materials:	Piece of sulphur, stranded iron wire, magnet, scissors, knife
	Procedure:	Have the children break the piece of sulphur in half. Put one half aside. With a scissor cut the other half and continue to cut. Have children imagine what the sulphur will be like in the breaking process when only a speck of sulphur is left. Follow the same procedure with a piece of stranded picture wire.

40. Leading Question: What is the size of atoms and molecules?

Materials: Marbles, beads, BB shot, thumbtacks, paper clips, gravel or sand, one ounce paper cups

Procedure: Have the children fill separate cups with each of the materials listed. Which cup contains the greatest number of objects? Are these the smallest or the largest objects? Children should observe that the smaller the size of an object, the more objects of that size can be packed into a given space.

41. Leading Question: What charge is found on a rubber comb when rubbed by wool?

Materials: Hard rubber or plastic comb, plastic bag or nylon cloth

Procedure: Rub a hard rubber or plastic comb with a plastic bag or a piece of nylon cloth. Test the electric charges on the comb and the bag to see whether they are negative or positive.

Note to teacher: A negative charge is found on a hard rubber comb when rubbed by wool. It will repel other negatively charged objects. Suspend a negatively charged comb. Bring the other charged articles near it to discover if the comb is attracted or repelled.

42. Leading Question: What are the forms of energy?

Materials: None

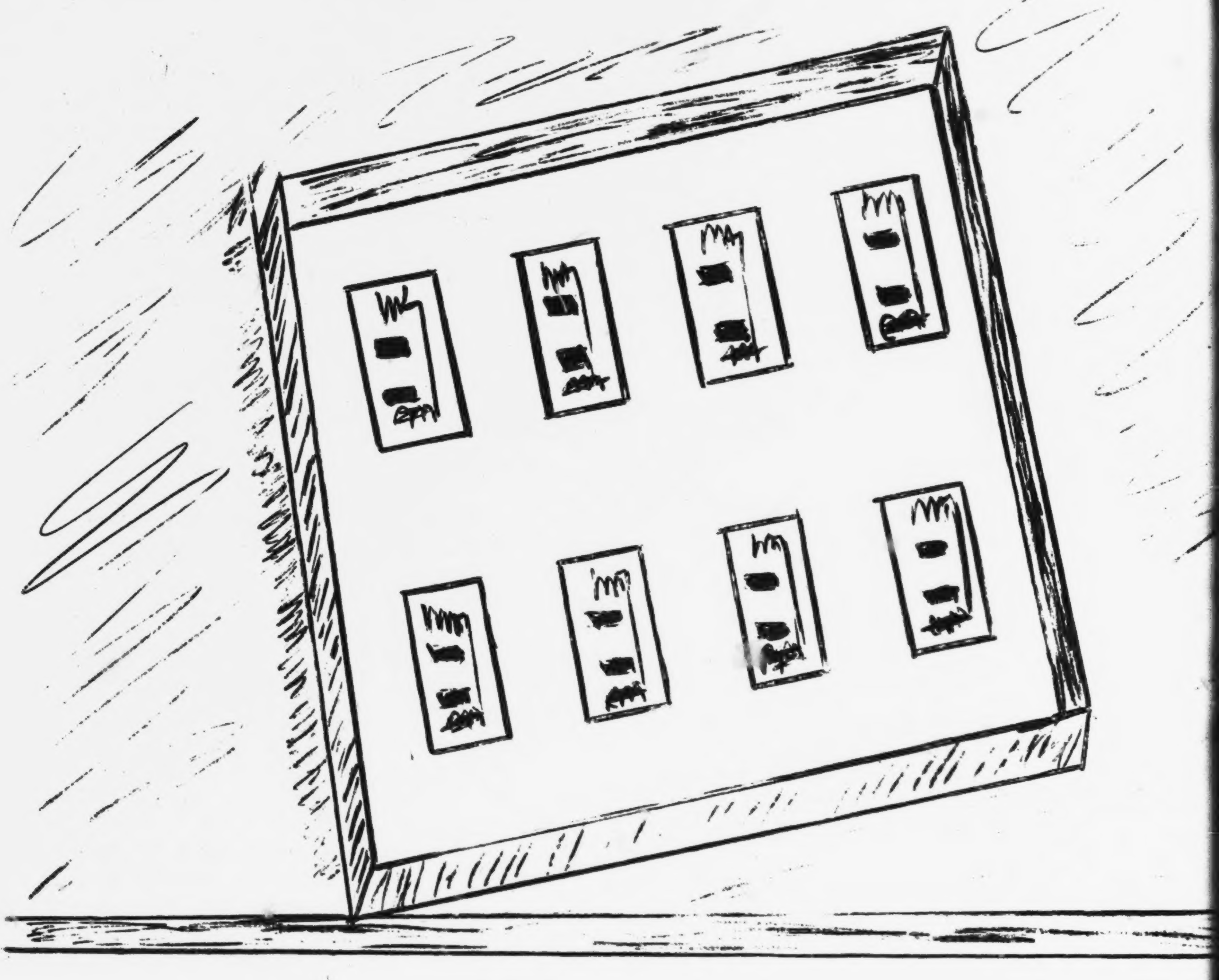
A. Procedure: Divide the class into eight groups. Have each responsible for a type of energy:

electrical
atomic
heat
sound
mechanical
chemical
radiant
muscular

Have each group explain their type of energy and perform an experiment or activity to illustrate the type of energy.

B. Procedure: Allow an able student to demonstrate Activity A, by using an electroscope. Then have him place the electroscope on an overhead projector and observe the reaction!

43. Leading Question:	What is a chain reaction?
Materials:	Eight mousetraps, 16 corks, box
Procedure:	Place eight mousetraps in the bottom of a box. Set each trap with two corks (neutron) on the arm of the trap. Then drop one cork into the box. As the cork springs a trap the corks (neutrons) will shoot out and spring other traps. The "chain reaction" will continue until every trap is sprung.
Note to teacher:	The cork represents a neutron shooting toward uranium atoms.



44. **Leading Question:** How do scientists find out about the nature of the atom without actually seeing the atom?

Materials: Shoe box, lid, small objects

Procedure: In a shoe box place simple unknown objects and cover the box. The pupils have to find out about the nature of the objects in the box without uncovering the box.

Have resourceful students devise activities to demonstrate the leading question.

45. **Leading Question:** How can we become familiar with atomic numbers?

Materials: Pencil, paper, element chart

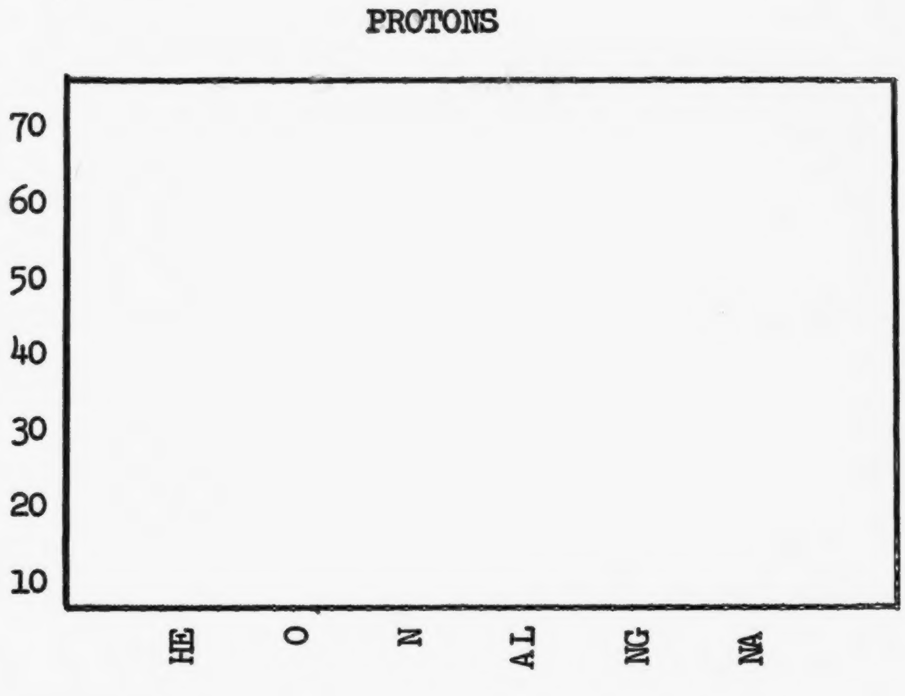
Procedure: Have children send code messages to one another using the symbols and atomic numbers of the elements.

46. **Leading Question:** How can we become familiar with number of protons and neutrons in various atoms?

Materials: Graph paper, colored pencil

Procedure: Have the pupils graph the relationship between the number of neutrons and protons of various atoms.

Example:



47. **Leading Question:** How does radioactivity affect photographic X-ray film?

Materials: Watch or clock that has a dial painted with a radioactive substance, piece of x-ray film (used by dentist) larger than dial

Procedure: In a dark room, wrap black paper around the x-ray film. Place the watch or clock face down on the black paper, then put all of this in a light-tight box or drawer for at least 24 hours.

Remove the film in a dark room. You can develop the film yourself by following the directions on packages of x-ray developer and x-ray fixer, or you can have the film developed by a professional developer.

Note to teacher: The intensity of radiation from luminous dials varies greatly. You may need to experiment with exposure time before you get a satisfactory picture.

48. **Leading Question:** How can we show that scientists are organized?

Materials: Oaktag, copy of Periodic Table of Elements (available as transparency from IMC center)

Procedure: Have children cut squares for each element of the periodic table of elements. With magic marker put the information concerning number and atomic weight on each square.

Arrange the table correctly and prepare a display.

Note to teacher: Have several reports prepared about the men who developed the Periodic Table. Have the class realize that because of the chart some elements were known to exist before they were discovered.

49. **Leading Question:** How can we find out about atom piles and "atomic smasher"?

Procedure: Have a few children write to the U.S. Atomic Energy Commission, Washington, D.C. and request information.

Use the materials for reports and discussion.

Have some children prepare clay or wooden models of devices illustrated in this material.

50. Leading Question: How can we locate radioactive rocks?

Materials: Geiger counter (see science helping teacher or Civil Defense) rock samples

Procedure: Place a sample of rocks around the room. Include some rocks that are slightly radioactive. Give pupils a Civil Defense Geiger counter and have them find the radioactive rocks.

51. Leading Question: How does matter become energy?

Materials: Coal, open flame source

Procedure: The simple act of burning coal will illustrate matter becoming energy. This can be demonstrated in a variety of ways.

   1. Using a bunsen burner, hold a piece of coal in the flame with a pair of tongs (use hot pads to hold the tongs.)
   2. Using a small charcoal burner, ignite charcoal to demonstrate matter becoming energy--heat energy.

52. Leading Question: How does radiation affect plant life?

Materials: Seeds exposed to neutrons in reactors, soil, pot (available from Edmund Scientific Co.)

Procedure: Give the pupils some seeds to plant and see if they can find any mutations in the plants when they mature.

53. Leading Question: How can energy become matter?

Procedure: Plant two identical plants. Put one in the dark and one in the sunlight. After three weeks observe both plants which have been watered, but only one of which has been exposed to the energy of the sun.

NATURE OF MATTER

TEXTBOOK INDICES

PUBLISHER: **Allyn & Bacon** SERIES: **Exploring Science** EDITION: **1964-66**

Nature of Matter	Related Pages in Texts							
	K	1	2	3	4	5	6	7
K DISCOVERING MATTER	**61-72**							
1 MATTER AROUND US								
States of Matter		**61-72**						
Changes of Matter			**67-80**	**21-36**				
4 CHANGES OF MATTER								
Molecular theory								
Physical and Chemical Change					**49-64**			
Compounds and Mixtures								
6 ATOM AND MOLECULES								
Nature of Matter								
Nature of the Atom								

PUBLISHER: **American Book Co.** **SERIES:** **Thinking Ahead in Science** EDITION: **1965**

Nature of Matter	Related Pages in Textbooks							
	K	1	2	3	4	5	6	7
K DISCOVERING MATTER	6 - 37							
1 MATTER AROUND US								
States of Matter		6 - 37	52-67	94-102				
Changes of Matter			6-9					
4 CHANGES OF MATTER								
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Compounds and Mixtures				104-109		29-32		
6 ATOM AND MOLECULES								
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PUBLISHER: **Bobbs Merrill** SERIES: **The World of Science Series** EDITION: **1966**

Nature of Matter	Related Pages in Textbooks K	1	2	3	4	5	6	7
K DISCOVERING MATTER		56-74 104-134						
1 MATTER AROUND US								
States of Matter		56-74 76-102		178-191				
Changes of Matter		104-134	156-180	192-194				
4 CHANGES OF MATTER								
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PUBLISHER: **D. C. Heath & Co.** SERIES: **Heath Science Series** EDITION: **1965 (3rd Ed.)**

	Related Pages in Textbooks							
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K DISCOVERING MATTER		21-24 116 118-119	131-132 76-77					
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States of Matter								
Changes of Matter								
4 CHANGES OF MATTER								
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6 ATOM AND MOLECULES					54 84-85			
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PUBLISHER: Ginn & Co. SERIES: Discovering Science EDITION: 1958

	Related Pages in Textbooks							
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K DISCOVERING MATTER								
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4 CHANGES OF MATTER								
Molecular theory								
Physical and Chemical Change								
Compounds and Mixtures								
6 ATOM AND MOLECULES								
Nature of Matter								
Nature of the Atom								

PUBLISHER: Ginn & Co. SERIES: Science for You EDITION: 1965

Nature of Matter	Related Pages in Textbooks K	1	2	3	4	5	6	7
K DISCOVERING MATTER								
1 MATTER AROUND US								
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Changes of Matter		66-71 20-25	36-68					
4 CHANGES OF MATTER								
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Physical and Chemical Change						211-225		
Compounds and Mixtures								
6 ATOM AND MOLECULES					7-26			
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Nature of the Atom						91-101 211-225		

PUBLISHER: Harper & Row SERIES: Today's Basic Science EDITION: 1963-1965

Nature of Matter	Related Pages in Textbooks							
	K	1	2	3	4	5	6	7
K DISCOVERING MATTER	6-17							
1 MATTER AROUND US								
States of Matter		17-28		18-40				
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PUBLISHER: Holt, Rinehart & Winston SERIES: Science/A Modern Approach EDITION: 1966-1967

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K DISCOVERING MATTER		6-65						
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Changes of Matter				143-173				
4 CHANGES OF MATTER								
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PUBLISHER: Lyons & Carnahan **SERIES:** Developmental Science Series **EDITION:** 1958–1964

Nature of Matter	Related Pages in Textbooks							
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K DISCOVERING MATTER								
1 MATTER AROUND US								
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Physical and Chemical Change						6–25		
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PUBLISHER: Scott, Foresman SERIES: Our Foundation Series EDITION: 1965

	Related Pages in Textbooks							
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K DISCOVERING MATTER								
1 MATTER AROUND US								
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4 CHANGES OF MATTER								
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PUBLISHER: Silver Burdett Co. SERIES: Silver Burdette Science Program EDITION: 1965

Nature of Matter	Related Pages in Textbook K	1	-	3	4	5	6	7
K DISCOVERING MATTER	8-21							
1 MATTER AROUND US								
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4 CHANGES OF MATTER								
Molecular theory				96-100	54-55	6-28	14-23	
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PUBLISHER: L. W. Singer Co. SERIES: Singer Science Series EDITION: 1962

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Nature of Matter	K	1	2	3	4	5	6	7
K DISCOVERING MATTER			82, 85 63					
1 MATTER AROUND US								
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4 CHANGES OF MATTER								
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PUBLISHER: Singer Random House ERI Science Through Discovery ION 19

Nature of Matter	Related Pages in Textbooks K	1	2	3		5	6	7
K DISCOVERING MATTER								
1 MATTER AROUND US								
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Changes of Matter				88-100				
4 CHANGES OF MATTER								
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Compounds and Mixtures				102-111				
6 ATOM AND MOLECULES								
Nature of Matter								
Nature of the Atom								

PUBLISHER: Harcourt, Brace & World **SERIES:** Classroom Lab. **EDITION:** 1966

Nature of Matter	Related Pages in Textbooks K	1	2	3	4	5	6	7
K DISCOVERING MATTER								
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States of Matter		37	50-52					
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4 CHANGES OF MATTER								
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PUBLISHER: **Harcourt, Brace & World** SERIES: **Concepts in Science** EDITION: 1966

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6 ATOM AND MOLECULES								
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Nature of the Atom							289-306	

PUBLISHER: **Winston Co.** SERIES: **Understanding Science** EDITION: **1957**

Nature of Matter	Related Pages in Textbooks							
	K	1	2	3	4	5	6	7
K DISCOVERING MATTER		1-20						
1 MATTER AROUND US								
States of Matter		107-110	113-125	37-98				
Changes of Matter			137-146					
4 CHANGES OF MATTER								
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Physical and Chemical Change						117-160	203-224 243-278	
Compounds and Mixtures						129-130		
6 ATOM AND MOLECULES								
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PUBLISHER: American Book Co. SERIES: ABC Science Series EDITION: 1-1

Nature of Matter	Related Pages in Textbooks K	1	2	3	4	5	6	7
K DISCOVERING MATTER								
1 MATTER AROUND US								
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PUBLISHER: **D. C. Heath & Co.** SERIES: **Heath Elementary Science** EDITION: **1959-1961**

Nature of Matter	Related Pages in Textbooks K	1	2	3	4	5	6	7
K DISCOVERING MATTER		147-151 11						
1 MATTER AROUND US								
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Changes of Matter			50,106- 107,37- 39,50-51					
4 CHANGES OF MATTER								
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Compounds and Mixtures				104-110			108	
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PUBLISHER: **Macmillan Co.** SERIES: **Macmillan Science Series** [illegible]N: [illegible]6

Nature of Matter	K	1	2	3	4	5	6	7
	Related Pages in [illegible]							
K DISCOVERING MATTER			2-9					
1 MATTER AROUND US								
States of Matter		7	2-9					
Changes of Matter		9-15 21-25	109-145					
4 CHANGES OF MATTER					[illegible]	167-210	36-95	
Molecular theory					242-250			
Physical and Chemical Change				170				
Compounds and Mixtures					315			
6 ATOM AND MOLECULES						167-210	36-95	
Nature of Matter								165-167 42 39-45
Nature of the Atom								245-290

PUBLISHER: **Harper & Row** SERIES: **Today's Basic Science** EDITION: 1967

Nature of Matter	Related Pages in Textbooks							
	K	1	2	3	4	5	6	7
K DISCOVERING MATTER								
1 MATTER AROUND US								
States of Matter								
Changes of Matter			180-195					
4 CHANGES OF MATTER								
Molecular theory					28-34			
Physical and Chemical Change					176-179			
Compounds and Mixtures								
6 ATOM AND MOLECULES								
Nature of Matter								
Nature of the Atom						287-313	317-342	

PUBLISHER: **Laidlaw** SERIES: **Science Series** EDITION: 1966

	Related Pages in Textbooks							
Nature of Matter	K	1	2	3	4	5	6	7
K DISCOVERING MATTER								
1 MATTER AROUND US								
States of Matter		98-104	132-134					
Changes of Matter								
4 CHANGES OF MATTER								
Molecular theory				150-178	212-217			
Physical and Chemical Change					196-211			
Compounds and Mixtures					215			
6 ATOM AND MOLECULES								
Nature of Matter							173-200	
Nature of the Atom							200-205	

PUBLISHER: Scott, Foresman SERIES: **Curriculum Foundation** EDITION: **1961-1964**

	Related Pages in Textbooks							
Nature of Matter	K	1	2	3	4	5	6	7
K DISCOVERING MATTER		54-76 21-34						
1 MATTER AROUND US								
States of Matter		21-34		6-15				
Changes of Matter			24-46					
4 CHANGES OF MATTER								
Molecular theory					61-76			
Physical and Chemical Change								
Compounds and Mixtures								
6 ATOM AND MOLECULES								
Nature of Matter								65-81
Nature of the Atom								68, 142, 308

PUBLISHER: SERIES: EDITION:

	Related Pages in Textbooks:							
Nature of Matter	K	1	2	3	4	5	6	7
K DISCOVERING MATTER								
1 MATTER AROUND US								
States of Matter								
Changes of Matter								
4 CHANGES OF MATTER								
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Nature of Matter								
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Compounds and Mixtures								
6 ATOM AND MOLECULES								
Nature of Matter								
Nature of the Atom								

NATURE OF MATTER

APPENDIX

CHEMICALS FOUND IN THE HOME AND SCHOOL

COMMON NAME	CHEMICAL NAME
alum	potassium aluminum sulfate
ammonia (household)	dilute ammonium hydroxide
aspirin	acetyl-salicylic acid
baking soda	sodium bicarbonate
beet sugar	sucrose
benzine	gasoline
bleaching powder	calcium chloro-hypochlorite
blue vitriol	copper sulfate
boracic acid	boric acid
borax	sodium tetraborate
camphor, artificial	pinene hydrochloride
cane sugar	sucrose
chalk	calcium carbonate
chlorox	dilute sodium hypochlorite
dry ice	solidified carbon dioxide
epsom salts	magnesium sulfate
gypsum (sheet rock)	calcium sulfate
iodine	tincture of iodine
lemon juice	citric acid
lime	calcium oxide
marble	calcium carbonate
milk of magnesia	magnesium hydroxide
muriactic acid	hydrochloric acid
plaster of Paris	calcium sulfate
peroxide	hydrogen peroxide
putty powder	stannic oxide
quick lime	calcium oxide
quicksilver	mercury
rock salt	sodium chloride
saccharin	bensoic sulfinide
sal ammoniac	ammonium chloride
salt	sodium chloride
slaked lime	calcium hydroxide
soap	sodium stearate
soda (washing)	sodium carbonate
vinegar	dilute acetic acid
wood alcohol	methyl alcohol

EQUIPMENT THAT IS HANDY TO HAVE IN A PRIMARY CLASSROOM

basin
large glass jars
paper cups
paper plates
paper bags
cheese cloth
large cardboard
straight pins
magnetic pins
plastic bags
food coloring
large tray
ball of string
balloons
tire pump
straws
sponge
coffee cans with plastic top
plaster of Paris
steel wool (not soap pads)
piece of window screen
stockings
paper tissues
measuring cup
milk bottle (glass)
baby food jars
paper clips
crayon
chalk
marbles
soap
rocks
glass
buttons
hammer
leaves
plant
spoons
strainer

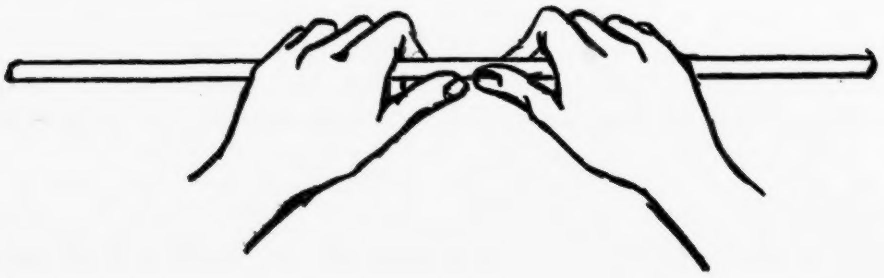
LABORATORY PROCEDURES

HOW TO USE THE PROPANE BURNER

First strike a match about a foot away from the burner, turn the gas, and bring the lit match to the top of the collar.

CUTTING GLASS TUBING

Put the glass tube flat on a clean desk or table. Make a single deep scratch with a triangular file. Do not "saw" the glass. Hold the tube with both hands, with thumbs below the mark. Turn the scratch away from you, and push with the thumb while you pull with the little fingers.

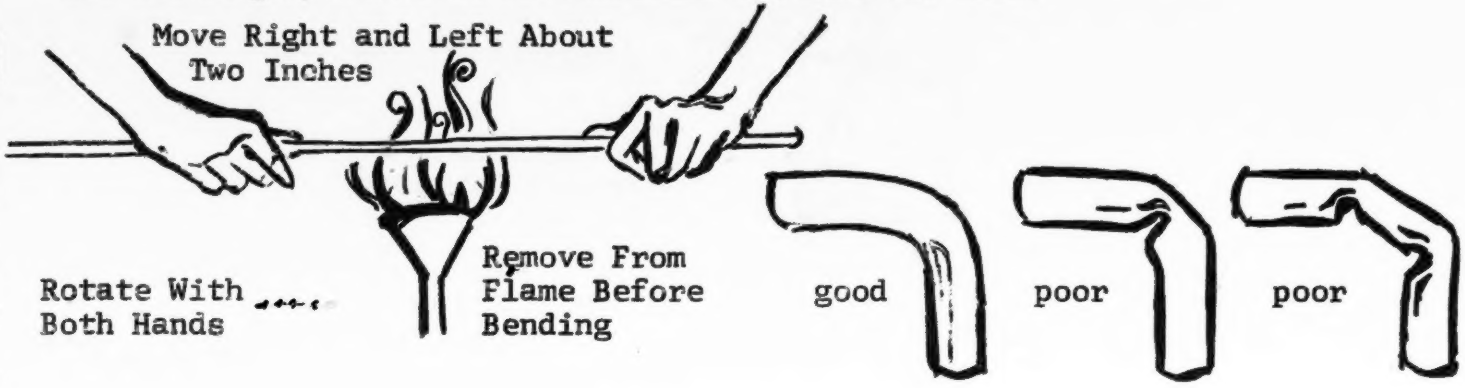


FIRE POLISHING

Fire polishing is removing the sharp edges from glass by a flame. Hole the end of the glass tube in the hottest part of the flame and rotate back and forth. Remove the tube from the flame. Lay the tube across another piece of glass tubing and allow it to cool. Do not lay the tube flat on the table for it will stick and burn the surface.

BENDING GLASS TUBING

If available, use the wing top attachment for the propane burner. Successful bending of glass tubing requires that a considerable portion of the tube is heated in a uniform matter. Hold the glass tubing horizontally along the wide portion of the flame above the blue region. Heat about two inches of the glass tubing where you want to bend it by rolling and moving it back and forth over the flame. When you sense that the glass tube is soft enough to bend under its own weight, remove it from the flame and make the bend.



MAKING A JET POINT

In order to make a pipette type of tube or a jet point rotate about 1½ inches of glass tubing in the flame of a propane tank. When the glass is quite soft remove from the flame and draw it out with a determined pull. Do not hesitate once you have started - pull in one swoop. When the tubing has cooled, cut with a file.

HEATING LIQUIDS

Both glass and porcelain are poor conductors of heat, and may crack if heated only in one spot (even if the glass is Pyrex). The flame should be moved back and forth to achieve a degree of uniformity in heating, and avoiding over-heating at any one point. Better yet, the flame may be allowed to fall upon metal gauze, a better conductor of heat, which tends to spread out the heat.

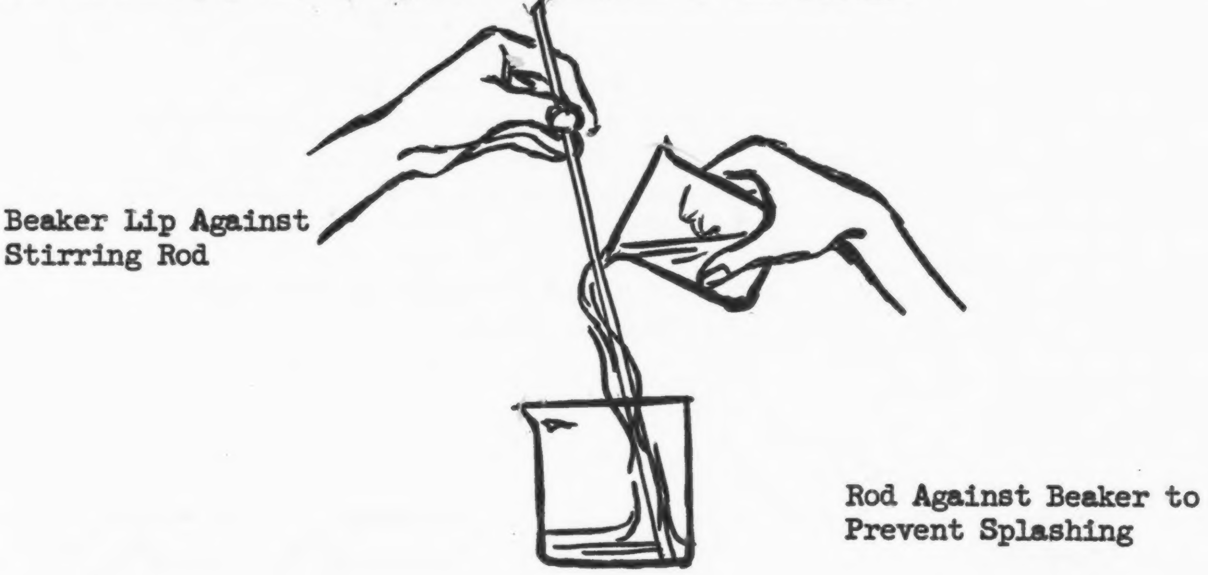
Heating liquids in test tubes - small amounts of liquids may be heated in test tubes held by a clamp at an angle of about 45° over the flame. Do not apply the flame at the bottom of the test tube - the contents may shoot out with great force. NEVER point the mouth of the test tube toward anyone or yourself.

HEATING SOLIDS

Place the test tube on a stand and move the flame of the burner back and forth to heat the contents evenly.

POURING LIQUIDS

To avoid splashing when pouring liquids from a beaker, hold a stirring rod against the pouring edge. When pouring from a bottle, keep the glass stirring rod vertical, pressing against the mouth of the bottle.



INSERTING GLASS TUBES IN A RUBBER STOPPER

Always wet glass tubing and rubber stoppers with water before inserting the glass tubing into the rubber stopper. Use a to and fro twisting motion. DO NOT try to force or push through the stopper.

Rubber stoppers tend to stick to glass tubing when allowed to dry. Removing them from apparatus after use will help prevent accidents. For an added safety precaution, wrap a towel or cloth around the rubber stopper and glass tube.

WEIGHING CHEMICALS

When weighing out dry chemicals place equal size tissue or similar paper on the pans of the balance scale. NEVER pour a chemical directly on the pan.

DILUTING ACIDS

Concentrated acids are very dangerous chemicals. These should be handled with extreme caution and stored in a safe place where pupils do not have access to it.

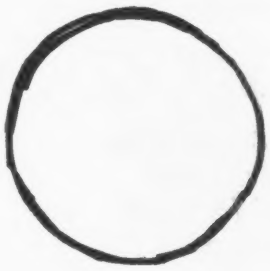
When diluting acids, slowly add acid to water with constant stirring. NEVER ADD WATER DIRECTLY TO CONCENTRATED ACID. Considerable heat is released when acid reacts with water. If this is done improperly a dangerous spattering may result.

If acid fumes or sprays get on the skin, wash the area immediately with water and continue washing with water.

FOLDING FILTER PAPER

Most schools have filter paper available, however, paper towel can be substituted.

Fold the paper along the diameter, then once more at right angles, making a quandrant. Nest it, then unfold it in a way to make a cone which has one thickness of paper along one side and three thicknesses along the other. Place the cone in a funnel moistened with water, and press snugly into the funnel in order to squeeze out all bubbles of air.



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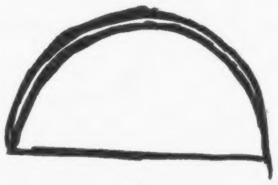

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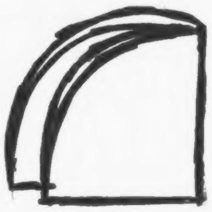

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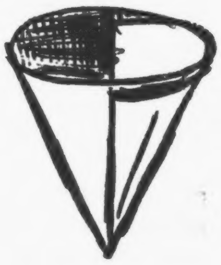

4

A SUMMARY OF IMPORTANT CHEMICAL PRINCIPLES

1. FUNDAMENTAL IDEAS

a. States of Matter

1. Matter exists in three physical states: gas, liquid, and solid. The relationship between the states of matter in terms of heat can be expressed as follows:

$$\text{Gas} \underset{-\text{ heat}}{\overset{+\text{ heat}}{\leftrightarrows}} \text{Liquid} \underset{-\text{ heat}}{\overset{+\text{ heat}}{\leftrightarrows}} \text{Solid}$$

b. Chemical Equation

2. An equation represents a fundamental weight relationship between the starting substances (reactants) and the products (resultants) of a chemical reaction. The sum of the weights of all the reactants equals the sum of the weights of all the resultants. By using the proper density factors, the weights may be converted into the corresponding volumes.

c. Atoms

3. All atoms consist of a positively charged nucleus surrounded by shells of negatively charged electrons. The electrical charge on the nucleus is equal to the atomic number. The atomic number also represents the total number of electrons in the shells. Atoms are therefore electrically neutral. Differences between atoms of various elements are due to differences in the number and arrangement of particles in these atoms.

d. Valence Number

4. The valence number of an atom is equal to the number of electrons that the atom can lend, borrow, or share in a chemical change.

e. Ions

5. An ion is an electrically charged particle having the same nuclear structure as the atom or group of atoms from which the particle was derived. The charge on the ion depends on the number of electrons lost or gained by the atom or group of atoms during a chemical change.

f. Organization

6. Electropositive elements generally occupy the left side of the table while electronegative elements generally occupy the right

side. Elements which form amphoteric compounds are usually found near the center of the table.

g. Oxidation-Reduction

7. Oxidation is a process in which a particle loses electrons. As a result of the loss of electrons, there is an increase in positive valence number of a decrease in negative valence number.

8. In electrolysis, oxidation always takes place at the anode, while corresponding reduction always takes place at the cathode.

h. Electrolytes

9. Solutions of acids, bases, and salts that conduct an electric current are called electrolytes. An electric current passing through an electrolyte produces an oxidation-reduction reaction which causes the electrolyte to decompose.

MELTING POINTS OF SOME COMMON MATERIALS

Material	°F.	°C.
Alcohol, ethyl	-179*	-117*
Mercury	- 38	- 39
Carbon Tetrachloride	- 9	- 23
Wood's metal	158	70
Camphor	352	178
Tin	449	232
Lead	621	327
Aluminum	1219	660
Salt, common	1474	801
Silver	1761	961
Gold	1945	1063
Copper	1981	1083
Iron	2795	1535
Quartz (sand)	2912-3092	1600-1700
Platinum	3224	1774
Tungsten	6098	3370

* A minus sign (-) before a temperature means below zero.

SOME COMMON COMPOUNDS

Common Name	Chemical Name	Formula	Uses
Alcohol, grain	Ethyl alcohol	C_2H_5OH	Solvent, antifreeze
Alcohol, wood	Methyl alcohol	CH_3OH	Solvent, antifreeze
Ammonia water	Ammonia hydroxide	NH_4OH	Household cleaning
Baking Soda	Sodium bicarbonate	$NaHCO_3$	Baking, fire extinguishers, medicines
Carbon tetrachloride	Tetrachloromethane	CCI_4	Cleaning fluid, fire extinguishers
Chloroform	Trichloromethane	$CHCI_3$	Anesthetic, solvent
Cream of tartar	Potassium hydrogen tartrate	$KHC_4H_4O_6$	Cooking, in baking powder
Dry ice	Carbon dioxide (solid)	CO_2	Refrigeration
Glycerine	Glycerol	$C_3H_5(OH)_3$	Lotions, antifreeze, explosives
Limestone	Calcium carbonate	$CaCO_3$	Building material, fertilizers, refining iron
Limewater	Calcium hydroxide (solution)	$Ca(OH)_2$	Making bleaching powder, water softening
Lye or caustic soda	Sodium hydroxide	$NaOH$	Cleaning, making soap
Plaster of Paris	Calcium sulfate	$(CaSO_4)_2 \cdot H_2O$	Molds and casts, plastering
Quicklime	Calcium oxide	CaO	Mortar
Sand, silica, or quartz	Silicon dioxide	SiO_2	Building, glass
Soap	Sodium sterate	$C_{17}H_{35}COONa$	Washing
Sugar, cane or beet	Sucrose	$C_{12}H_{22}O_{11}$	Food
Table salt	Sodium chloride	$NaCI$	Food, preserving food, chemical manufacturing
Vinegar	Acetic acid (with water)	CH_3COOH	Flavoring, pickling foods
Washing soda	Sodium carbonate	$Na_2CO_3 \cdot 10\ H_2O$	Washing, glass

	Atomic Weight
Hydrogen	1
Helium	4
Carbon	12
Oxygen	16
Iron	56
Copper	63
Nickel	58
Silver	107
Tin	120
Gold	197
Uranium	238
Lawrencium	257

SOME WELL-KNOWN ELEMENTS

Name	Symbol	How Usually Found	General Characteristics
Aluminum	Al	Combined in clay and rocks	Metal that does not corrode
Argon	A	Free in the atmosphere	Colorless gas that never combines in nature
Bromine	Br	Free in oceans but scarce	Liquid uniting with metals
Calcium	Ca	Combined in limestone, shells, bones, and teeth	Metal that unites readily with oxygen
Carbon	C	Free in coal and diamonds; combined in carbon dioxide, limestone, and living things	Black solid or clear crystal, unites readily with other elements
Chlorine	Cl	Combined in table salt	Greenish-yellow poisonous gas
Copper	Cu	Combined in ores	Good conductor of electricity
Gold	Au	Free in rocks	Does not unite readily
Helium	He	Rare but common in stars	Light gas that never combines
Hydrogen	H	Combined in water and all living things	Gas, the lightest element, unites readily
Iodine	I	Combined in some seaweeds	Gray solid
Iron	Fe	Combined in many rocks	Combines readily with oxygen
Lead	Pb	Combined in ores	Soft, heavy metal
Magnesium	Mg	Combined in many rocks and certain ocean salts	Light metal that unites readily with oxygen
Neon	Ne	Free in air	Gas that does not combine
Mercury	Hg	Combined in ores	Heavy, silvery liquid
Nitrogen	N	Free in air; combined in most living things	Gas that does not unite easily
Oxygen	O	Free in air; combined in most common compounds	Gas that unites readily with many other elements
Phosphorus	P	Combined in phosphate rocks and most living things	Solid that unites readily with oxygen

SOME WELL-KNOWN ELEMENTS (Cont'd)

Name	Symbol	How Usually Found	General Characteristics
Potassium	K	Combined in rocks, ocean salts, and living things	Soft metal that unites readily with oxygen
Radium	Ra	Combined in ores; scarce	Metal that gives off radiations
Silicon	Si	Combined in most rocks	A hard solid that unites readily
Silver	Ag	Free, or combined in ores	Excellent electrical conductor
Sodium	Na	Combined in sea water and rocks	Metal that unites readily
Sulfur	S	Free in some rocks; combined in many ores, and in most living things	Yellow solid that unites readily with oxygen and many metals
Tin	Sn	Combined in ores	Metal not easily corroded
Uranium	U	Combined in ores; scarce	Metal that gives off radiations
Zinc	Zn	Combined in ores	Soft metal, used in dry cells

PERCENTAGE OF ELEMENTS IN THE EARTH

(Crust, Oceans, and Atmosphere)
By Weight

	Percent
oxygen	49.5
silicon	25.8
aluminum	7.5
iron	4.7
calcium	3.4
sodium	2.6
potassium	2.4
magnesium	1.9
hydrogen	0.9
titanium	0.6
all others	0.7
Total	100.0%

TABLE OF ELEMENTS OF FAMILAR ATOMS

Name	Symbol	No. of electrons (and protons)	No. of neutrons
hydrogen	H	1	0
helium	He	2	2
lithium	Li	3	4
carbon	C	6	6
nitrogen	N	7	7
oxygen	O	8	8
neon	Ne	10	10
aluminum	Al	13	14
phosphorus	P	15	16
sulfur	S	16	16
chlorine	Cl	17	18
calcium	Ca	20	20
iron	Fe	26	30
nickel	Ni	28	31
copper	Cu	29	34
zinc	Zn	30	35
arsenic	As	33	42
silver	Ag	47	61
tin	Sn	50	69
iodine	I	53	74
wolfram (tungsten)	W	74	110
platinum	Pt	78	117
gold	Au	79	118
mercury	Hg	80	121
lead	Pb	82	125
radon	Rn	86	136
radium	Ra	88	138
uranium	U	92	146